

THE
Philosophical Works

Of the HONOURABLE

ROBERT BOYLE Esq;

Abridged, methodized, and disposed under the
GENERAL HEADS

OF

PHYSICS,	}}	NATURAL HISTORY,
STATICS,		CHYMISTRY, and
PNEUMATICS,		MEDICINE.

The whole illustrated with NOTES, containing the *Improvements* made in the several *Parts* of natural and experimental *Knowledge* since his time.

V O L. III.

By PETER SHAW, M. D.

L O N D O N:

Printed for W. and J. INNYS, at the *West-End* of St. Paul's;
and J. OSBORN, and T. LONGMAN, in *Pater-Noster-Row*.

M. DCC. XXV.

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By PETER SHAW, M.D.

LONDON

Printed for W. and J. Innes, at the Half-Bush of St. Paul's;
and J. Osgood, and T. Longman, in Paternoster-Row.

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T O

The Right Honourable

The Lord *Shannon*.

MY LORD,

SUCH was the merit of the Honourable Mr. *Boyle*, such his abilities and public spirit, that, perhaps, no man ever deserved a greater, or bore a fairer character. The honour he reflects upon his noble family and your Lordship, is worthy of that he derives from thence. Never were a polite education and a philosophical genius improved more to the advantage of mankind, to private satisfaction and true glory, than by the great Mr. *Boyle*; that noble example for the imitation of men of plentiful fortunes, and a philosophical taste, in laying out their lives to their own and the public

The DEDICATION.

lic advantage. And whence can we with more justice expect, or whence more frequently arise, such bright examples, than from your Lordship's noble family, which inherits the virtues that have render'd the name of Mr. *Boyle* so deservedly famous?

The two former volumes of the abridgment of his incomparable philosophical writings being put under the protection of competent judges; this third begs your Lordship's acceptance; that the whole may be submitted to such as know to set a just value upon philosophical merit, and have a natural and tender regard for the original author.

I am,

May it please your Lordship,

Your Lordship's most humble,

most obedient,

And most devoted Servant,

Peter Shaw.

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PREFACE.

NATURAL HISTORY.

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THE P R E F A C E.

N*atural history seems at present to lie under some disgrace, upon account of the small benefit that is presumed to arise from the study of it. And, indeed, if a notion be formed of the whole thereof, from a few of its parts which have been dryly treated by some virtuosi, a rigid philosopher might be apt to condemn it as trifling and almost useless to mankind. A real philosophic genius, bent upon its own improvement, sees with indignation, the life of a virtuoso spent among shells and insects; and wishes the same time and application laid out to nobler purposes. These things, however, have their use; and we ought not to despise all that we our selves have no relish for. There will, and 'tis necessary there should be men of various tastes; and 'tis happy for the world that no part of philosophy remains uncultivated. But if any man has a despicable opinion of natural history in general, let him look upon it in that view wherein Mr. Boyle consider'd it; for here, as in every thing else, our excellent author has regarded usefulness and the benefit of mankind. Natural history, as managed by him, has no superfluous branches; nothing that barely amuses the mind, without gratifying and delighting it; nothing that entertains the fancy, without being serviceable in life: and his history of the air, his way of making salt-water fresh, &c. are eminent instances of it. But natural history, in its extent, he found to be a very large field, that required a great number of hands to*

P R E F A C E.

be employ'd in it ; and therefore, to render it as useful and complete as possible, he endeavour'd to engage many of his friends in the study thereof. 'Twas his custom to distribute all such large undertakings under proper heads, and so dispose of those heads separately to persons whom he respectively knew well qualified to cultivate and improve them. But he found few such diligent searchers into nature as himself ; and therefore received little assistance in this way from his friends. Hence several parts of his schemes of titles remain unspeaken to ; and this is particularly the case in the following history of the air. Mr. Boyle, however, performed wonders of himself ; his inquisitive genius lead him to abundance of particulars which esape the knowledge of others ; and these he generously communicates. Were this practice encouraged, and were more heads and hands employ'd after the same manner, the world might in time see what Mr. Boyle has here laid the foundation of, a complete natural history ; by means whereof philosophy it self wou'd, at length, be completed also.



H E A D S

HEADS

FOR THE

NATURAL HISTORY

OF A

COUNTRY.

THE general heads for the natural history of a country will respect the heavens, the air, the water, and the earth.

To the first belong the longitude and latitude of the place, and consequently the length of the longest and shortest days, the climate, parallels, and the visible fix'd stars; with the constellations whereto 'tis said to be subject.

The heavens.

Of the air may be observed its temper, as to heat, dryness and moisture, with the measures of them; its weight, clearness, refractive power, subtilty or grossness, its abounding with, or wanting an esurine salt; its variation according to the several seasons of the year, and the times of the day: how long the several kinds of weather continue; what sort of meteors the air most commonly breeds; in what order they are generated, and how long they usually last: to what winds 'tis liable; whether any of them be stated, ordinary, &c. What diseases are epidemical, that are suppos'd to arise from the air: to what other diseases the country is subject, in the production whereof the air is concerned. What is the usual state of the air as to the health of the inhabitants; and with what constitutions it agrees better or worse than others. The gravity of the air is to be learnt by the barometer.

The air.

With regard to the water are to be consider'd the sea, its depth, specific gravity, difference of saltness in different places, the plants, insects, and fishes to be found in it, tides, with respect to the adjacent lands, currents, whirl-pools, &c. rivers, their bigness, course, inundations, taste,

The water.

Heads for the natural History

NAT. HIST. taste, subterraneous passages, fruitfulness, &c. lakes, ponds, springs, and especially mineral waters; their kinds, qualities, virtues, and how examin'd; the sorts of fishes, their size and goodness, plenty, seasons, ways of breeding, haunts, and the methods of taking them; especially those that are not purely mechanical.

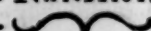
The earth. In the earth may be observed it self, with its inhabitants and productions, as well internal as external; its dimensions, situation, east, west, south, or north; its figure, plains, hills or valleys; their extent, the height of the mountains, either in respect of the neighbouring valleys, or the level of the sea; whether the mountains lie scatter'd or in ridges; and whether those run north or south, east or west, &c. What promontories, fiery or smoaking hills, &c. the country has; whether subject to earthquakes or not. Whether the country is coherent, or much broken into islands. What declination the magnetic needle has in several places at the same time; and how much it varies in different times at the same place: whether before hurricanes, the needle loses its direction towards the north; and turns equally to all the points of the compass. The nature of the soil, whether of clay, sand, gravel, &c. its peculiar qualities, and productions, as to minerals, vegetables and animals: and how all these are or may be farther improved for the benefit of man.

Inhabitants. Under inhabitants are to be considered both the natives and the strangers who have been long settled there; particularly as to their stature, shape, features, strength, ingenuity, diet, inclinations and customs, that seem not due to education. In the women, their fruitfulness or barrenness, their easie and hard labour, with their exercises and diet; the diseases, with their symptoms, and the diet, air, &c. that influence them.

Vegetables. The external productions are trees, fruits, plants, &c. with the peculiarities observable in them. In what soils, and with what culture they thrive best; with what animals or insects the country abounds, and to what use applied by the inhabitants, as to food, physic, surgery, &c.

Minerals. By the internal productions of the earth are here understood things generated in the bowels of it, either to the benefit or hurt of man. Under these are comprehended metals, minerals, stones, precious or common. To examine how the beds of them lie in reference to north or south, &c. What clays and earths are afforded, with their the physical or other uses; what coals, salts, or salt-springs, alum, vitriol, sulphur, &c. The number of mines, their situation, depth, signs, waters, damps, quantities of ore, extraneous things, and ways of reducing their ores into metals, &c.

Traditions. Add to these the inquiries about traditions of all particular things relating to the country, such as are either peculiar to it, or at least uncommon elsewhere.

Enquiries that require learning or skill to answer; with proposals NAT. HIST. for ways to enable men to give answers to such more difficult enquiries. 

To observe the declination of the compass in different longitudes and latitudes; setting down the method by which the observation was made. Inquiries for the sea.

To observe the dipping-needle, in the like manner.

To observe the odour, colour, and taste in sea-water; the proportion of its salt in different places; whether in the same sea it be constantly the same; and what are the particularities of that sea-water, where ships cables soonest rot, and where they are best preserved.

To remark, if there be near the south pole a constant current, setting from the south so forcibly, that ships with a stiff gale can hardly make way against it; and near the north, a current forcibly carrying ships towards the pole; or if this motion reciprocate once in half a year.

To observe what subterraneous passages there are, whereby seas communicate with one another.

What effect the winds have upon the seas; and how far from the surface they agitate the waters.

The ebbs and flowings, with the age of the moon when the neap and spring-tides happen; to what height it ebbs and flows at these times upon the coast, or the islands far off in the sea; and if it flow there differently from the tides near the main land; and how much sooner it begins on one side than another.

To mark narrowly the way of coming into particular creeks and harbours; with their bearings and distances from the neighbouring places.

To sound all along at coming in; and to mark the depths and shallows near the shoar, or farther off from the coast, as also near shelves or banks.

To mark in the sounding not only the depth, but all the grounds, whether clayie, sandy or oufie, &c. To mark whether the sea always rises towards the shore, unless accidentally hindered. How the bottom of the sea differs from the surface of the earth; with the stones and minerals to be found there.

To take notice of the winds, their changes, or set times of blowing, and in what longitude and latitude, especially the trade-winds; upon what coast the trade-winds are most frequent; and by what signs they may be foreseen.

To observe and record all extraordinary meteors, lightnings, thunders, and their effects, *Ignes fatui*, comets, &c. marking the places of their appearing and disappearing.

To examine the weights of the several waters that occur, both near the upper and lower part of the sea; the power ascribed to the sea of throwing up amber, ambergreece, &c. and its shining in the night.

The

NAT. HIST. The medicinal virtues of the sea ; especially in the hydrophobia. Its virtue to manure land ; and to learn what plants thrive best with sea-water.

*Inquiries for
mines.*

Whether the country wherein the mines are, be mountainous, plain, or distinguish'd with valleys? And in case it be mountainous, what kind of hills are they, whether high, low, or indifferently elevated? Whether almost equal, or very unequal in height? Whether fruitful or barren; cold or temperate; rocky or not; hollow or solid? Whether they run in ridges, or seem confusedly plac'd; and if the former, what way the ridges run, north or south, &c? and whether they run nearly parallel to one another?

What the country produces, and what in most plenty?

What cattle it sustains? Whether they have any thing peculiar in point of bigness, colour, longevity, fitness or unfitness for food, &c. which may rather be attributed to the peculiar nature of the place, than the barrenness of the soil, or other manifest causes?

What health the inhabitants enjoy? What diseases they are subject to, and to what not? And what remedies are known for the epidemic diseases of the place?

What plenty of rivers, brooks, lakes, springs, &c. in the place; the colour, taste, &c. of them; and how they affect the health of such as use them?

How the air is disposed as to heat or cold, calms or winds; and whether these winds proceed from, or are infected with subterraneous steams? Whether these steams are clear or foggy?

Whether the soil near the surface of the earth be stony; and if so, what sort of stones it abounds with; whether the soil be clayie, marly, or chalky; and of how many kinds it is; and by what properties they are distinguish'd?

By what signs a mine is conjectured to be in a place?

And as these signs are either above or beneath the surface of the earth, it must be farther inquired whether the ground be made barren by metalline or mineral effluvia?

What trees or plants grow most plentifully in these places, and whether they thrive well or ill? Whether they be discolour'd in their leaves, or have their outsides chang'd?

What alteration is produc'd in the waters of the place, either as to their colour, taste, smell, weight; or what matter they leave upon the stones they run over?

Whether snow or ice continue as long in these as in the neighbouring places?

Whether the dew that falls on the ground will discolour white linen? And whether the rain will discolour cloaths, or afford any residence of a mineral nature?

Whether thunder, lightnings and storms are frequent here? And if there be any fiery meteors and nocturnal lights?

Whether mists arise from such mineral grounds; what is observable NAT. HIST. in them; what minerals they signify, and may be suppos'd to be produced by?

Whether the *Virgula divinatoria* be us'd for finding out the mines, and with what success?

Whether there be any clays, marles, or other mineral earths, and of what consistence, that give notice of the ores; and at what depth they lie, in respect of one another, and how thick they are?

What stones, marcasites, &c. are found near the surface; what is the particular shape, bigness, colour and weight of such stones, whereby they are distinguishable from others?

Whether heat or damps signify a mine?

Whether water found in digging be a sign of a mine?

By what signs the nearness of a mine is known; and whether any sign will shew a person to be above, beneath, or on the side of the mine?

By what signs the determinate kinds of metals are known, with their plenty and goodness?

What signs there are of the depth of the vein; of the mine's being hopeless, or that 'tis unlikely to find a vein in the place 'tis digged for?

What is the depth of the shaft or groove, till you come at the vein or ore; whether the vein run or lie horizontally; or if it dip, what inclination it hath; and how deep the lowest part lies?

What are its flexures, or whether it runs directly north or south, east or west, or seem rather to have a casual tendency than any natural determination; and how far it reaches in all?

What is the wideness of the groove at the top and elsewhere; whether it be perpendicular or crooked; and if crooked, after what manner, and with what distance it winds?

How the groove is supported; what the kinds, length, bigness, and way of placing of the timber, poles, &c. employ'd to support it; and how long the wood continues, without being spoil'd by the subterraneous fumes and waters; and what wood lasts the longest?

What air-shaft belongs to the mine; whether it be single or double, of what breadth at the orifice; whether it be convenient or not; how near 'tis plac'd to the groove, and in what position; if there be several air-shafts, what their distances and situation with regard to the groove, and to each other; and how is air supply'd, if there be no air-shafts?

Whether they meet with waters, and what plenty there is of them; at what depth they are found; how qualified, and what way they spring, &c?

Whether they are constant or temporary; whether they increase or diminish in the summer, or at any time of the year; and what that season is, how long it lasts, and the proportions of increase and decrease?

What engines or contrivances are used for drawing up the water, and conveying it away; the materials they are made of, the parts, the bigness, the coaptation, and whole structure, and way of applying the instruments used to free the mines from the water?

NAT. HIST.

What are the conditions, number, &c. of the adits?

Whether the mines be troubled with damp, and of what kind they are; whether they come often or seldom, at any Time of the year, or irregularly?

What signs precede them; what mischief they do; what remedies are the most successfully employed against them, as well in reference to the clearing of the mine, as to the preservation and recovery of the men?

What methods the mine-men use in following the vein, and tracing their passages under ground, according to the several exigencies; and whether they employ the instruments made with the help of the loadstone, the same way that is usual; and, if not, wherein they differ in the use of the same instruments, or what they substitute in their place?

By what means they secure themselves against the uncertainty where-to the magnetical needle is subject, when it comes near iron ore; and what other means may be used, besides a load-stone, to help a miner?

How the miners deal with the rock and spar they meet with, before they come at the ore; and how they use fire to soften, calcine, or crack them, and with what success?

By what means they free the mines and the workmen from the inconveniencies arising from the great use of fire?

With what instruments they break the rock; how they are conducive, and how long they last?

How the miners work, whether cloathed or naked; what lights they use; what materials they are made of; and what measure of illumination they afford; how long they last; and by what ways they are kept burning in that thick and foggy air?

How veins are followed, lost, and recover'd; and how several miners work on the same vein; and what is the best way of getting all the ore in a vein, and that most conveniently?

How they convey out their ore, and other things that are to be carried up; what kind of vessels they use for matter, shape and capacity, and whether the workmen deliver them one to another, or the same workmen carry them all the way; and whether they descend and ascend by ladders of wood or ropes, &c?

Whether the ore runs in a vein, or lies dispers'd, or be divided partly into a vein, partly into loose masses, or like a wall between two rocks, as it were in a cleft; or be interspers'd in the firm rock, like speckled marble; or be found in grains, like sand or gravel; and what is observable in it as to weight, colour, mixture, &c?

Whether any part of the metal be found in the mine perfect and complete?

Whether the mine affords any parcels of metal that seem to grow like plants?

Whether the vein lie near the surface of the earth, and at what depth; whether it have any peculiar concomitants or coats; and if

if any, what they are, and in what order they lie? Thus the veins of NAT. HIST. lead ore with us have frequently annexed to them a substance called spar, and next to that another call'd calk; and whether they have any other heterogeneous substance?

What are the principal qualities of these extraneous substances?

Whether the vein be inclos'd every way in its coats, or lie only between them?

Whether the vein be every way of an uniform breadth and thickness; and if it be, what the dimensions are; and if not, in what places it varies, and by what measures?

Whether the vein be uninterrupted, or in some places broken off; whether abruptly or not; and whether by vales, brooks or gullets, &c?

How wide the interruptions are; by what signs the veins may be found again; whether the farther division of the vein be of the same nature, and hold on in the same course, as to its tendency upwards and downwards, or horizontally, northward or southward, &c. with the vein from which 'tis cut off?

Whether, in case the last end of the vein be found, it terminate abruptly, or in some kind of rock or earth, which, as it were, closes it up, without leaving any crack, or otherwise; whether the terminating part of the vein tends either upwards or downwards, or neither; whether in the places where the vein is interrupted, there be any peculiar stone or earth that seals up the extremity of it?

Whether it be observ'd that the ore, in tract of time, may afford any gold or silver, which it affords not, or more than it would afford, if it were not so ripe; and whether it has been found that the metalline part of the vein grows so, that some part of the ore will afford metal in tract of time, that did not so before; and whether to this maturation of the mine, the being expos'd to the free air be necessary; or whether, at least, it conduce to the acceleration of it, or otherwise?

Whether all the ore contain'd in the mine be of the same nature and goodness; and if not, what are the differing kinds, and how to be distinguish'd and estimated?

What is the fineness and goodness of the ore, by which the mine is usually estimated; and what the marks and characters that distinguish one sort from another?

What proportion of metal the ore affords?

Whether the ore be pure, in its kind, from other metals; and if not, of what metals it participates, and in what proportion?

What previous operations are us'd to the melting of the ore, as beating, grinding, washing, &c. and with what circumstances; as how long the ignition lasts at a time; whether the ore be suffer'd to cool of it self, or be quenched; whether it be wash'd betwixt each ignition; or whether the ore requires no such preparations, as it often happens in lead, and sometimes in iron?

NAT. HIST. Whether mercury is made use of in separating the nobler from the baser metals?

Whether the ore be expos'd to the air, as a preparative?

What flux-powders they use to examine their ores in small quantities?

Whether in reducing or melting great quantities they use any flux-powder; what it is, and how employed?

What is the contrivance of the furnaces, and if they be all of one, or of differing sorts or bigness?

What tools are used in smelting, and how contriv'd?

What fuel they use, and how much is spent in a day; and what returns they have of metal, in a proportionate time?

Whether the ore be melted by means of a wind, made by the fire's own motion, by water, or by bellows; if the latter, what their dimensions are, and what way us'd?

What way they take to let out the metal that is in fusion, to cast it into bars, fows, pigs, &c. and what clay, sand, or mould they let it run through; and after what manner they cool it?

Whether to facilitate the fusion, they mix several ores of the same sort together?

Whether after 'tis once melted, they melt it again, to make it more pure; and if so, with what circumstances they perform it?

Whether they have signs to know when the fusion is well or ill perform'd, and that the metal has obtain'd a perfection requisite in such a fusion, and such a furnace?

Whether they observe any difference in the goodness of the metal that comes first, from that which comes last; and whether the rule holds constantly?

Whether the produc'd metal be all of the same goodness; and if so, how good it is compared with the metals of other mines, or other parts of the same vein; and if it be not, what differences are between the produced portions of metal, and what disparity that makes in the price?

What are the ways of distinguishing them, and estimating their goodness?

Whether flowers be not elevated to the upper parts of the chimney; and whether they are barely excrementitious or metalline?

Whether, when the ores are brought to fusion, they have any recrements; what these recrements are, and how to be separated from the baser metal?

Whether, after the metal has been melted, the remaining part of the ore will, in tract of time, be impregnated with more metal?

Whether the air appears really to be cool in summer, and hot in winter, at the bottom of the mine, by more evident proofs than the testimony of our touch?

Whe-

Whether they find the stones and ground actually hot, so that sometimes they can hardly stand upon the place; and if so, from whence this proceeds? NAT. HIST.

Whether there be mineral juices in the mine that harden into stones or metals, upon contact with the air?

What laws, constitutions and œconomy are observ'd among the miners?

In what way the trees and their leaves are affected by the mineral fumes and juices, and if they be gilded or silver'd; if these trees be more ponderous than others; if they have any metalline or mineral concretes lodg'd in their pores?

Whether there be waters and springs observ'd to rise near the mines, and run their whole course under the ground, without ever appearing above it?

Whether the subterranean springs rise with any wind, or determinate change of weather?

How much heavier the atmosphere is at the bottom than at the top of the mine; and whether damps considerably increase the weight of the air?

Whether any strange substances are found in the mine, as vessels, anchors, fishes inclos'd in spar or metal, &c?

What is the way of making pot-ashes?

What is to be observed about amber; is it an exudation of the sea, soft when first cast on shore; at what season of the year, and in what manner taken up, &c?

Enquiries particularly about cold, for Poland, and the more northern countries.

What is to be observed in the digging of *Sal gemma* in Poland; and what is the depth of the mines stored with the salt; and what their distance from the sea?

What truth is there in that relation, of swallows being found under waters congeal'd in winter, and reviving when held to the fire?

Whether there be in the *Bodnic-bay* a whirl-pool, as is related to be in the sea of *Norway*, which is commonly called the *Maal-stroom*; and whether there be any signs of the communication of those gulphs by subterraneous passages?

To what depth the cold in these parts reaches, in the earth and water?

Whether watches are made to go slower by the cold?

Whether oil, in great colds, is turned into true, hard and brittle ice?

Whether they can freeze a strong brine of bay-salt, a strong decoction of *Sal gemma*, foot, or a strong solution of salt of tartar, or sugar of lead?

Whether they can congeal meer blood without the ferous part, Canary wine, solutions of all salts, and strong solutions of metals?

Whether an intense and lasting frost makes any alteration in quicksilver, exposed very shallow, and in a flat Vessel?

Whe-

NAT. HIST. Whether the purgative virtue of cathartics be increased, diminished, or even totally destroyed by a strong continual cold?

Whether harts-horn, and the like substances thawed, will yield the same quantity of spirits as they do when they have not been frozen?

What are the effects of cold in the fermentations of liquors?

Whether birds and wild beasts grow white in the winter-time, and recover their native colour in summer?

Whether colours may be concentrated by cold; for instance, that of a strong decoction of cochineal in a fit glass?

Whether the electrical virtue of amber, and the attractive force of the magnet, will be changed by vehement cold?

Whether thick pieces of iron and steel be made brittle by intense frosts; so that smiths are obliged, for prevention, to give their tools a softer temper?

Whether accurate observations shew, that all fishes die in frozen waters, if the ice be not broken; or whether the cold it self, or the want of changing or ventilating the water, or the privation of air, be the cause of their death?

Whether any skilful anatomist has enquired, by freezing some animals to death, after what manner it is that intense cold kills men; whether they have found ice in the inward parts, as the brain and heart, and in the large vessels?



M E M O I R S

FOR A

GENERAL HISTORY

OF THE

A I R.

1. *THE constant ingredients of the air, or atmosphere.*
2. *The ather in the atmosphere.*
3. *The elastic particles of the air and its spring.*
4. *The magnetic particles of the air.*
5. *The destruction, generation, absorption, and extrication of the air.*
6. *The accidental ingredients of the air.*
7. *The aqueous particles in the air, with the moisture and dryness thereof.*
8. *Clouds, mists, and fogs.*
9. *Terrestrial steams in the air.*
10. *Salts in the air.*
11. *Sulphur; inflammable particles in the air; lightning and its effects.*
12. *Celestial influences or effluvia in the air.*
13. *The height of the atmosphere.*
14. *The motion of the air; and winds.*
15. *The air consider'd as the medium of sounds. Noises in the air, and particularly thunder. The air's operation on the sounds of bodies.*
16. *The weight of the air.*
17. *The consistence of the air; its rarity, density, fluidity, and subtilty.*

*Heads for a
general history
of the air.*

18. *The*

- NAT. HIST. 18. *The heat and coldness of the air.*
 19. *The air consider'd in relation to light; its perspicuity, opacity, reflexions, refractions, colours, &c.*
 20. *The operation of the air on the consistence of animal, vegetable and mineral substances.*
 21. *Air consider'd with regard to fire and flame.*
 22. *Air, as it regards fermentation.*
 23. *Air consider'd as the receptacle of odours.*
 24. *The air's operation on the odours of animal, vegetable and mineral substances.*
 25. *The operation of the air on the tastes of animal, vegetable and mineral substances.*
 26. *The operations of the air on the colours of animal, vegetable and mineral substances.*
 27. *The air considered as destroying or introducing less obvious qualities into animal, vegetable and mineral bodies.*
 28. *Air consider'd with regard to the propagation and vegetation of plants.*
 29. *The air consider'd with the regard to the generation, life and health of animals.*
 30. *Heavy bodies sustain'd by, or taken up into the air.*
 31. *Dew.*
 32. *Rain.*
 33. *Hail.*
 34. *Snow.*
 35. *Unusual things falling out of the air.*
 36. *Miscellaneous experiments and observations on the air.*
 37. *Desiderata in the history of the air; with proposals to supply them.*

Definition of
the air.

AIR here signifies the thin, transparent, compressible and dilatible fluid, wherein we breathe and move, that surrounds the whole surface of the earth to a considerable height, and differs from the æther in refracting the rays of the celestial luminaries.

The air may be considered both as transient and permanent. For example, if an æolipile of water be sufficiently heated, and suffer'd to expel the particles of air by its aqueous vapour, this will afterwards be forcibly driven out in a large quantity, like the blast of a pair of bellows, and occasion a sharp, whistling noise against the edge of a knife conveniently held thereto. Yet such a vapour, tho', whilst the motion lasts, it resembles air, soon loses that resemblance, especially in the cold, and returns, by condensation, to its original water.

Many

Many are the experiments I have made upon the air, but farther trials appear necessary to determine its nature. I conjecture, however, that the atmospherical air consists of three different kinds of corpuscles; the first, those numberless particles which, in the form of vapours or dry exhalations, ascend from the earth, water, minerals, vegetables, animals, &c. in a word, whatever substances are elevated by the celestial or subterranean heat, and thence diffused into the atmosphere. The second may be yet more subtle, and consist of those exceedingly minute atoms, the magnetical effluvia of the earth, with other innumerable particles sent out from the bodies of the celestial luminaries, and causing, by their impulse, the idea of light in us. The third sort is its characteristic and essential property, I mean permanently elastic parts. Various hypotheses may be framed relating to the structure of these latter particles of the air. They might be resembled to the springs of watches, coil'd up and endeavouring to restore themselves; to wool, which being compressed, has an elastic force; to slender wires of different substances, consistences, lengths and thickness; in greater curls or less, near to, or remoter from each other, &c. yet all continuing springy, expansible and compressible. Lastly, they may also be compared to the thin shavings of different kinds of wood, various in their lengths, breadth and thickness. And this perhaps will seem the most eligible hypothesis; because it, in some measure, illustrates the production of the elastic particles we are considering. For no art or curious instruments are required to make these shavings, whose curls are in no wise uniform, but seemingly casual; and what is more remarkable, bodies that before seem'd unelastic, as beams and blocks, will afford them. Hence also we may perhaps fetch an illustration of some experiments, wherein I found that various, solid, and mineral bodies, unsuspected of elasticity, being plunged in corrosive unelastical menstrea, will, upon a proper comminution of their parts, afford in the conflict a considerable quantity of permanently elastic air. But many other figures, and some perhaps more proper, may be attributed to these elastic corpuscles.

All I shall add is, that tho' air seem to continue elastic, upon account of its structure, rather than any external agitation, yet heat, which is a kind of motion, may make the agitated particles endeavour to recede from the centres of their motion, and to repel those that would hinder their free rotations; and thus greatly add to the attempt it makes towards expansion. And by this means there may perhaps be mixed with the springy particles, others whose elasticity is owing more to their motion than their structure; that variously whirling them, so as to remove the adjacent corpuscles, and thereby promote an expansive force in the air they go to compose. Some of these, indeed, may, in very cold climates and seasons, prove of a like kind with what I above shew'd to be of a short duration; yet others of them may be so minute, agile, and advantageously shaped, that at least, in our climate, the air will be

NAT·HIST. warm enough to promote its own agitation, and keep it self fluid, and give a competent motion to particles so well disposed to preserve it.

*The spring of
the air.*

Figure 1.

" We find that in blowing up a football the included air gradually
 " increases in its resistance, and not only thus opposes its own conden-
 " sation, but also endeavours to expand it self. Whence we are furnish-
 " ed with a method of making fountains to play, and of shooting off bullets
 " by the spring of the included air. But because 'tis difficult to com-
 " press air to any considerable degree with the natural strength, 'twill
 " be proper to apply the skrew to that office, in the following manner.
 " Suppose for a fountain, the metalline vessel ABE, made concave at the
 " top, with a hole A, for the water to enter at; which, running in, will
 " force out the air thro' the open tube CD. Before the vessel is fil-
 " led, let the hole A, be close stopped with a skrew, and turn the stop-
 " cock, E, to close that end. Place next a little bucket on one side within
 " the vessel, with its embolus HI, whose upper part must be fixed to
 " the moveable ear of the vessel. The embolus HK, being perforated
 " quite thro', should have a valve fix'd to it at the hole S, to hinder
 " the air, there sent out, from returning; and the like is to be done
 " externally at the bottom of the bucket, I. Let the cylindrical sur-
 " face of the embolus be cut into a male skrew, and fitted to a female
 " one in the plate MN, which may be fastened externally as a prop
 " to the ear of the vessel, by means of two small skrews in M, and N.
 " When the water is in, these small skrews M, and N, are to be
 " loosened, and the plate to be raised from the vessel up to the han-
 " dle HO, whereby the embolus being drawn out, the air passes thro'
 " the perforation HS, to fill the bucket; and upon thrusting the embo-
 " lus down, the valve at S, is shut, and the air forced out at the bucket
 " thro' the valve I, into the vessel, whence it can neither escape nor
 " force out the water; both the stop-cock and hole at A, being shut;
 " consequently it is condensed; and at a second elevation of the em-
 " bolus endeavouring to expand it self, the valve I, is thereby forc-
 " ibly pressed against the hole in the bucket, and that passage block-
 " ed up. When, by repeated strokes, so much air is forced in, as
 " causes the embolus to go very stiff, the plate MN, is again to be skrew-
 " ed on; and the pump may be further work'd, by taking hold of the
 " handle in O, and gradually revolving the embolus backwards and
 " forwards, by means of its skrews, till the air is very strongly compres-
 " sed, when opening the stop-cock E, the water will fly out at the
 " tube CD, at first with great vehemence, but less forcibly by de-
 " grees, as the elasticity of the air grows less. The like contrivance
 " will, also, proportionably serve in wind-guns, which may also be made
 " without any thing to receive the compressed air, after the manner
 " of the elder pot-guns, used by children, with their paper pellets.
 " For a long concave cylindar of iron being procured, two leaden bul-
 " lets, by means of paper, or the like, may be exactly fitted to its
 " bore;

“ bore; so that if a female skrew were cut on the internal surface of one end, whereto the male skrew cut on a solid cylindar of the same metal answered, which being a little shorter in length, and made to move in the other by a force applyed to a proper handle, till all the air contained in the cavity was condensed into a narrow compass between the two bullets, the foremost of them would be there- by thrown out of the tube with a prodigious force. ” *Casatus.*

NAT.HIST.

We put some copper filings, with a mercurial gage, into a conical crystal glass exactly fitted with a ground stopple, and poured upon the filings as much rectified spirit of fermented urine as rose an inch above them; then carefully stopping the glass, we several hours after perceived that the mercury in the sealed leg was considerably depressed; when letting in the external air, we found it to have a manifest effect upon the mercury. *Experiment 1.*

Into a like glass we put more copper filings, and poured thereon strong spirit of putrefied urine, till it rose about an inch above them, and having let down a mercurial gage, so that it rested against the bottom and side of the glass, we closed it with a stopple, and set it in a quiet and well illumin'd place; having first observed the station of the quicksilver in the gage. The menstruum work'd very calmly upon the filings, gradually acquiring a very pleasant blue colour, and the glass being kept at rest in the same place for two or three days longer, the liquor began to lose its colour, growing fainter by degrees, till at the end of three or four days it became very pale. Then admitting the external air, and leaving the vial in the same place and posture, I found within four or five minutes the upper part of the liquor of a fine blue colour, which in ten minutes time had diffused it self thro' the whole; so that in less than a quarter of an hour, the liquor was throughout of a rich blue colour, and in a few minutes longer grew opaque. When carefully closing the vial again, we set it in the same place, where the liquor began again, within two or three days, to lose its colour; so that I made a second experiment much like the former. The like success I had in a trial or two made in another glass, and once, with success, about nine a clock at night. In most of these experiments I forbore to shake the glass, lest that shou'd be suspected to raise some fine powder that might be precipitated out of the tincture, tho' I never perceived any such. But if by the agitation of the liquor more parts of it were exposed to the action of the air, the colouration would be hastened. *Experiment 2.*

Having covered the bottom of a conical glass with filings of good copper, we poured strong spirit of Sal armoniac upon them, till it rose about a finger's breadth above them; and having let down a mercurial gage, so that it rested against the bottom and side of the glass, we closed it very well with the stopple, and set it in a quiet well enlightened place, observing where the quicksilver rested in the gage. The menstruum work'd slowly on the filings, without producing any noise

NAT. HIST.

noise or sensible bubbles; gradually acquiring a very pleasant blue colour. We perceived also from time to time, that for two or three days together, the mercury in the sealed leg of the gage very slowly descended, till it appeared near a quarter of an inch lower than at first. The event of the experiment seemed sufficiently to argue, that the spring of the air, contain'd in the cavity of the glass, communicating with that in the open leg of the gage, was weakened in comparison of that of the closed leg; which by the hermetic seal on one side, and the quicksilver on the other, was kept from such communication. I further observed, that the depressoire continued at different times of the day; tho' at noon the sun shone hot upon the place and vessels. This experiment was made four or five times, but not always with equal, yet with some success; the mercury in the sealed leg of the gage being sometimes more and sometimes less, but always manifestly depressoire; which phenomenon was confirmed by the observation we more than once made of the sudden return of the mercury to its former station, upon unstopping the glass, to give free admission to the external air.

Experiment 4.

A mercurial gage being put into a conical glass, the bottom whereof was covered with beaten coral, we poured thereon some spirit of vinegar, and closing the neck exactly, observed many bubbles were for a long time produced, which successively broke into the cavity of the vessel, whereby they compressed the air in the close leg of the gage into about a third part of its former dimensions. But some hours after the corrosion had ceased, the compression made by this new air grew manifestly fainter, and the air imprison'd in the gage drove down the mercury again to within about one division of its first station; where it continued for five or six days. So that there here seems to have been a double compressive power exercised; the one transient, by the brisk agitation of the vapours or exhalations, and the other durable, from the aerial and elastic particles, either produced or extricated by the action of the spirit upon the coral.

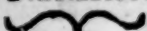
Experiment 5.

A considerable quantity of spirit of vinegar being put upon minium in a conical glass, furnished with a glass stopple and a mercurial gage, no sensible depressoire of the mercury appeared in either leg for several days; nor did any change happen in the gage upon removing the stopple, tho' it was evident by the great sweetness acquired, that a large proportion of the minium was dissolved.

Experiment 6.

Into a round eight ounce vial we put some copper filings and a mercurial gage, pouring strong spirit of Sal armoniac on the metal, till it reach'd to a considerable height in the vial, which being hermetically sealed, was set in a south window, where the liquor soon acquired a deep blue tincture, which in twelve days time grew gradually pale, till at length it appeared like water. During this, the mercury in the open leg seem'd to be impell'd up, and at about nine a clock at night we broke off the hermetic seal, upon which a noise was immediately pro-

pro-



produced, and the mercury in the shorter closed leg briskly impell'd to the height of near $\frac{1}{2}$ inch, and tho' the orifice whereat the air entered, would scarce admit a middle sized pea, yet within a minute and half the surface of the liquor appeared to have acquired a lovely fair colour, reaching downwards $\frac{1}{4}$ inch; so that the vial seemed to contain two very different liquors, swimming upon each other; and the colouration becoming gradually deeper, the whole within five minutes obtain'd a rich blue colour.

That air is greatly concern'd in producing many phenomena of nature, either altogether new, or not formerly ascribed to it, has been of late sufficiently shewn. And that it is also necessary to the existence and motion of most animals, may be easily deduced from my experiments made with the air-pump, relating to respiration. This fluid being of so great importance, made me solicitous to enquire, whether it was producible by art; for if so, it might help to explain some difficult phenomena; and be otherwise very serviceable in human life, as particularly in the art of diving, and submarine navigation.

Generation
and destruction
of air.

By the production of air, I here mean the obtaining a sensible quantity of that fluid from bodies wherein it did not before appear, either at all, or in so great plenty; tho' perhaps some of our experiments may argue a new and real production of air, in the stricter sense of the word.

This enquiry will consist of two parts; the methods of producing what appears to be air; and those of examining how far the substance produced has the real properties of air.

I must here observe, that many accidental qualities are ascribed to air; but having found what best distinguishes it from aqueous vapours, earthy exhalations, and the effluvia of other bodies, to be, as was said, a durable elasticity; I shall here make use of that as the principal critereon, to try whether any portion of matter be aerial.

Among the several ways of producing air, the fittest for practice seem to be fermentation, corrosion, and the dissolution of bodies, by the boiling of water and other liquors, by the mutual actions of bodies upon one another, especially saline ones, and lastly, by analysing and resolving certain substances.

Into a long and large tube we conveyed filings of steel, a proper quantity of water, a sealed glass of oil of vitriol, with a hole near one end, and a mercurial gage; when having exhausted the air from them all, till the mercury in the gage was almost wholly impelled into its open leg, we exactly closed up the external vessel: Then gradually, and at long intervals, pouring the included oil of vitriol upon the steel and water, exceeding large bubbles were thereby produced, with a small, sensible heat. During the conflict much air seem'd to be generated by these bubbles, so that, at length, the mercury in the gage, being impelled to the very bottom of the open leg, the air included in the other appear'd more compress'd than by the weight of the

Experiment 1.

NAT. HIST. the atmosphere, before 'twas thus employ'd. We removed the whole into a cooler room, where I found, the next day, no sensible alteration in the gage; and thus it continued for three or four days; but coming afterwards to look upon it, the mercury had ascended about an inch and a half; and near the same quantity of water had got into the sealed leg of the gage. But this was, very probably, owing to a care-less removal of the tube that had been made, without my knowledge; for I have found no other remarkable alteration herein since the experiment was first undertaken, which is now eight or nine days; the mercury in the open leg still remaining at about the height of an inch and half.

Experiment 2. I filled a pint vial with wheat-flower well drenched in water, stopping up the orifice both with cork and cement, and set it in a warm place of the laboratory, in a cold season; where it continued for thirteen days, when it burns by the dilation of the included matter, which was, the night before, observed to have left a considerable vacancy below the cork. The matter to me tasted sourish, but to another acid.

Experiment 3. We set a convenient quantity of bruised raisins to ferment with water, in a bolt-head, including also a mercurial gage therein; when exhausting the air, and preventing any from returning into the vessel, 'twas placed in the warm laboratory. No springy substance appear'd to be hence generated in four days, tho' the liquor, it seems, afterwards fermented more violently than the cold season might be thought to allow of; for being not carefully looked to, the middle part of the glass broke to immensely small pieces, with a report equal to that of a pistol; whilst the bottom and neck remain'd tolerably entire.

Experiment 4. I fill'd a wide-mouth'd three pint glass, with a proper quantity of water and bruised raisins. Upon the mouth of the glass we tied a large bladder by the neck, but first carefully freed from air, and fasten'd it well thereto with cement, to prevent any air from passing either in or out. In this condition we left the glass in the laboratory for fourteen days, when finding the bladder tumid, we should have tied up the contain'd air therein, but for a small hole there chanced to be in it. We therefore took it off, and caused a very limber one, capable of holding a quart of water, to be fix'd on in the same manner, and found it next morning so full of air, that we could not, without difficulty, and the loss of a considerable quantity, tie up the bladder near its neck. Another bladder was afterwards applied as the former, which next morning appear'd full, as if distended by means of a pair of bellows.

Experiment 5. In the bottom of a wide-mouth'd vial we lodged some good spirit of salt, and the filings of steel, covering all with a receiver, fitted with an eel-skin, and a wire, whereto a thin and slender glass, hermetically seal'd at the bottom, was fixed, containing some filings of copper. The receiver being well exhausted, we broke this glass of copper filings against the bottom of the vial, and let them fall into the menstruum, whence ensued great store of bubbles, which raised a froth much deeper

deeper than the liquor; and the successive generation hereof continued for a considerable time; some of them appearing large, tho' in the open they would, perhaps, have been invisible. The vial thus kept in *vacuo* for a quarter of an hour longer, and no greenness appearing in the liquor, the receiver was taken off. NAT.HIST.

A bubble of air, equal in diameter to a middle sized pea, being left at the top of a round vial, with a long and slender neck, and containing fine oil of turpentine, this was inverted into another vial of the same liquor, and suffer'd to stand in a quiet place for a competent time. The like was also done with spirit of wine at the same time. The event was, that in six days the bubble disappear'd in the glass of oil of turpentine, and likewise in that of the spirit of wine the day following. Experiment 6.

Upon opening an exhausted receiver, wherein was an unstop'd vial above half full of an opaque blackish liquor, supposed to have been frogs spawn, that had certainly been included for three years, we found by the gage put up with it, that it had yielded a little air. Its scent was fetid, like that of the pump of a ship, but it had produced no insects, nor was turn'd mouldy. Experiment 7.

An industrious gentleman of my acquaintance, who digs for mines, and owns a good one, informs me; that when the miners meet with running water under ground, they are thereby supplied with air sufficient for free respiration, even at the depth of many fathoms; but stagnant water, he said, would not do the like. Tho' in his opinion, that air proceeded rather from the water it self, than from its motion. Observation.

1. To produce air by fermentation in well closed receivers.
- To produce air by fermentation in seal'd glasses.
- To separate air from liquors by boiling.
- To separate air from liquors by the air-pump.
- To produce air by corrosion, especially with spirit of vinegar.
- To separate air by animal and sulphureous dissolvents.
- To obtain air in an exhausted receiver by burning glasses, and red-hot irons.
- To produce air out of gunpowder, and other nitrous bodies.
2. To examine the produced aerial substances, by their preserving or reviving animals, flame, fire, the light of rotten wood, and of fish.

Experiments about the production of air, and the examination of it, proposed.

To examine it by its elasticity, and the duration thereof.

To do the same by its weight, and its elevating the fumes of liquors.

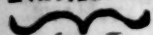
I am not solicitous that all the phenomena refer'd to the moisture of the air, be solely produced by the bare moisture thereof, 'tis sufficient if this quality is the most obvious one, tho' other corpuscles whereto moisture serves as a vehicle, be also concern'd herein.

The dryness and moisture of the air.

Dryness, as privative as its nature seems, may have a considerable share in producing a change in bodies, and that in differing respects; the two principal whereof are these.

First,

NAT. HIST.



First, by means hereof a body is deprived of those exhalable parts that harbour'd in its pores, and were perhaps the principal of several operations ascribed to it. Secondly, as the want of these more subtile parts may induce a change of texture in the body, chiefly with regard to its pores, whose magnitude, figure and position being alter'd, the body may in many cases acquire a contrary disposition to its own.

Observation.

Sometimes when the weather began to be overcast, the hygroscope did not grow sensibly heavier, and at other times it wou'd, when I cou'd observe no vapours in the air. Indeed it happened thus but seldom, yet this made me suspect that some clouds may consist of other than aqueous exhalations; and that such as are peculiarly fitted to enter the pores of the hygroscope, have a faculty of drying it, or some way or other of increasing or lessening its gravity. And this seems the more probable, because having made hygrosopes with powder, with salt, and with wainscot saw dust, applied to nice scales in very thin light open glasses, they all succeeded as the former; for now and then their weight would not alter as the weather grew moister or dryer.

Experiment 1.

Soon after looking upon the half hundred weight that hung by a rope, and fixing a mark where the bottom of it touch'd the perpendicular board that stood by it, I perceived the sky, which before was clear, to grow cloudy, but no rain ensued; upon this the weight rose a quarter of an inch within an hour and a quarter after the mark was made, as it proved, between nine and ten in the evening. Between eight and nine the following morning, it was raised near an inch from the former mark, when the day proving fair and windy, the weight sunk by ten at night about six inches below where I found it in the morning. The morning following, about eight a clock it was risen to $8\frac{1}{4}$ inches, the weather being then cloudy, tho' very dry and dusty; but in less than an hour after it overcast, and there fell some drops of rain, which made the lead to rise about half an inch higher.

The night proving rainy, the half hundred weight was lifted above five inches higher than I left it the preceding evening, but the day recovering to dry, windy, and warm, it was sunk by the next night considerably below all the marks. The rope whereby this weight was suspended, measured in diameter three eightieths and four decimal parts of the tenth of an inch.

Experiment 2.

A rope about three feet and a half in length from the point of suspension, and near three tenths of an inch in diameter, being stretched for some days by a leaden weight or quarter of the large hundred, which had a flat board placed underneath, just barely to support it; we at length moistened the rope thoroughly with water, by means of a sponge, whereby it first seemed to be rather a little lengthen'd than shorten'd; but in an hour or two it began to contract, so that the weight was raised considerably above the board whereon it rested before; on the same day, however, the weight sunk to its former place.

Tho'

Tho' *Morocco* be an inland town, seated in a very hot climate, where the soil is usually dry; yet I am inform'd that the nocturnal air proves exceeding damp and piercing, so as presently to produce rust upon such iron instruments as lie naked therein. NAT. HIST.
Observations.

Air too moist cannot be wholesom. The air about *Oakly* in *Buckinghamshire*, tho' a high country, is very moist between *Michaelmas* and *Alhallontide*, especially in rainy weather, and upon a thaw; so that the wainscots, stair-cases, and pictures, then stand of a water, which will afterward trickle down in large drops. But many houses at *Brill*, which stand exceeding high, have this to a much greater degree; for here the stair-cases, especially if laid in oil, will run down with water. The north and north-east sides of these houses are observed to be the dampest; for the furniture here will rot, if fires be not sometimes made in the rooms wherein it stands.

As by exhausting a receiver of air, we formerly tried whether the remaining medium wou'd thereby alter its temperature, as to heat and cold, so in the present experiment we endeavoured to find its disposition with regard to dryness and moisture. The hygroscope made with the beard of a wild oat, seem'd very proper for this purpose; but that not being procurable, we used one of gut-string. This was convey'd into a small receiver, that the effect might be the more sudden and conspicuous; yet no sensible alteration appear'd in the index upon extracting the air. And tho' we repeated the experiment, and then kept the receiver for a considerable time exhausted, the consequence was the same; but upon the re-admission of the air by the cock only, the index in a few hours considerably changed its place; so that hence the subtle matter in the supposed vacuum of the receiver, and consequently the more fluid part of the atmosphere, wherein the proper aerial particles float, appears not, in its own nature, to be very sensible either of cold or heat, dryness or moisture; tho' many other experiments remain to be tried, besides those wherein the air-pump, thermometer, and hygroscope are concern'd, before this can absolutely be determin'd. Experiment 3.

An excellent astronomer of my acquaintance, who frequently took the height of the clouds, very rarely found any even of the white ones, in fair weather, to be more than three quarters of a mile, and seldom above half a mile, from the surface of the earth. Clouds & mists.

A mist driving upon the sea towards the shoar, tho' without any sensible wind, will cause a greater swell of water than a brisk gale.

A moist bluish mist has been observed to ascend from ground that is somewhat moist in winter, and elsewhere after a warm day, or against fair weather in autumn, to the height of twenty or thirty feet, and then to subside again in dew.

A virtuoso of my acquaintance, who possessed a piece of ground wherein ran several veins of different metals and minerals, as also his son, a virtuoso, told me, they had frequently seen pillars, as it were of fumes, ascending thence like smoke, some whereof had no Terrestrial
steams in the
air.
scint,

NAT. HIST. scent, some an ill one, and some again a good one, tho' the latter happen'd but seldom. And I my self have known diffusive and lasting fogs that have proved very fetid.

Smoky steams frequently proceed from the air-shafts of mines whilst they lye unwrought; and the charcoal made of the wood that grows near the mineral mines in *Cornwal*, affords a manifest, arsenical, and sulphureous scent.

"A terrible exhalation arose from the *Cretan* sea, at the beginning of the summer of the year 721, which diffusing it self in the air, caused it to appear all on fire. The sea it self was also, by huge flaming stones that started from the isle called *Hiera*, heated to a violent degree." *Journal de Savans*. 1685.

The atmosphere a very compounded body.

Salts in the air.

The schools teach the air to be a warm and moist element, and consequently a simple and homogeneous body. Many modern philosophers have, indeed, justly given up this elementary purity in the air; yet few seem to think it a body so greatly compounded as it really appears to be. The atmosphere, they allow, is not absolutely pure, but with them it differs from true and simple air, only as turbid water does from clear. Our atmosphere, in my opinion, consists not wholly of purer æther, or subtile matter, which is diffused thro' the universe, but in great measure of numberless exhalations of the terraqueous globe; and the various materials that go to compose it, with perhaps some substantial emanations from the celestial bodies, make up together, not a bare indeterminate feculency, but a confused aggregate of different effluvia. One principal sort of these effluvia in the atmosphere I take to be saline, which float variously among the rest in that vast ocean; for they seem not to be equally mixed therein, but are to be found of different kinds, in different quantities and places, at different seasons.

The arguments that shew subterraneous effluvia, in general, ascend plentifully into the air, prove the same of saline ones in particular; since it has been demonstrated, that immense quantities of common, nitrous, aluminous, vitriolic, and perhaps other salts, rise among the various exhalations of the terraqueous globe. Nor is this the only means whereby the air may be impregnated with saline particles; for the action of the sun upon the superficial parts of the earth and sea, will, alone, supply that fluid with swarms of them. And the quantity hereof may be greatly increased in several places by such vulcano's as have open vents, by the smoke of the common culinary fires, &c.

We might here enquire, whether the salts of the air be really of different kinds; and if so, what those kinds are; and how it comes by them?

Many learned men talk much of a volatile nitre in the air, as the only salt wherewith that fluid is impregnated. I must own the air, in many places, seems to abound in corpuscles of a nitrous nature; but I don't find it proved by experiments to possess a volatile nitre. In all my practices upon salt-peter, I found it difficult to raise that salt by a gentle heat, and

and spirit of nitre, which is drawn by means of a vehement one, has quite different properties from crude nitre, or the supposed volatile kind in the air; for 'tis exceeding corrosive. And even the earth dug from under an old dove-house, and distill'd with slow fires, yielded nothing like that wherewith these men suppose the air to be stored. I am content, however, to admit their supposition as ingenious, till farther evidence be given for it; and this seems not impossible to be produced, at least as to particular times and places. For I would not be positive, that the subterraneous exhalations, or the rays of the sun, never volatilize any of the nitrous particles they act upon, and elevate them into the air, without destroying their texture like our fires. But this will not appear to be the only salt that impregnates the air, if we consider how vast a portion of the terraqueous globe is cover'd with the salt ocean, and what immense quantities of fossil salt are dug up in *Poland, Hungary, Transylvania, &c.* that sea salt is generally found mixed with nitre in the earth, and that it is with difficulty separated therefrom. For hence it should seem, that in many places, especially near the sea, the effluvia of common salt abound in the air equally, at least, with those of nitre.

In places abounding with marcasites, there is a fretting vitriolic salt largely dispersed thro' the air, which has been observed to rot the hangings of rooms, and other furniture; and to lie upon the surface of the ground in a whitish efflorescence, after the sun had heated the moist and blackish mould wherein it lay.

But farther, the air of particular places, as about great towns, &c. may likewise, probably, abound with volatile salts, of a contrary nature to acids. That places deep under ground may lodge such salts, seems not unlikely from the experiment of an acquaintance of mine, who caused to be dug up, at the depth of several yards below the surface of the earth, a large quantity of a certain kind of clay, abounding in minerals; whence he obtain'd, by simple distillation, a considerable parcel of spirit and salt, greatly resembling those of urine or hartshorn.

In places where much wood is burnt, numerous particles of volatile salt may easily be dispersed thro' the adjacent air; for wood-foot, which is only that small part of the smoke which adheres to the chimney sides, affords a volatile, saline spirit in great plenty; and not readily, unless by the scent, distinguishable from that of urine or hartshorn.

Moreover, the putrefaction of animal substances may supply the air with volatile salts, since some putrefied urine will, without distillation, afford saline and spirituous parts, which by their scent, &c. discover themselves to be volatile, even while swimming in their own large quantity of phlegm. The like, I believe, is observable in many vegetables; for some succulent ones being laid together in a heap, at a convenient season of the year, that they might rot, I found them, when the putrefaction had arrived to a certain degree, to yield a surprizingly fetid scent, like

NAT. HIST. that of carrion; and that a vegetable will of it self afford a dry volatile salt, I know by experience, having my self obtain'd it from a spirituous seed, tho' I must confess, not without previous incineration; and only from two or three such substances.

But the air of some places may, besides those simple ones already mention'd, contain some compound salts, since I have shewn, that particular saline spirits may meet and join together therein; as also that two liquors may be so order'd, that tho' one of them shall never, of it self, afford any thing in a dry form; yet its spirituous effluvia meeting with those of the æther, will produce a dry, volatile and saline body; which a mixture of the liquors themselves would not.

The many saline effluvia that rise with the other subterraneous steams, cannot, all of them, be well suppos'd of a simple and uncompounded nature. A very intelligent acquaintance of mine, who visited a vulcano in *America*, told me, that before he came near enough to the fire, to be very sensible of its heat, the skin of his face was so corroded, and the colour of his hair so changed by the exhalations, as to prevent his nearer approach thereto.

'Tis well known that about mount *Vesuvius*, the exhalations are of so saline and sulphureous a nature, that they adhere to the orifices of its vents, like the flowers of sulphur. And I have had stone brought me from some vulcano, with a white salt in its cavities; which, upon examination, proved a-kin to sal armoniac, and easily soluble in water; one part being very volatile, and the other remaining somewhat fixt; whence it seems very probable, the salt was compounded in the bowels of the vulcano; great quantities thereof having, as I am credibly inform'd, been cast up in the fiery eruptions; and therefore, since I found it sublimable, it might, by that means, be largely dispersed thro' the air.

Besides these saline substances of a determinate species, there are possibly, at certain times and places, other corpuscles in the air of a saline nature, but not reducible to any particular kind, which I therefore call anonymous. We have observed in old glass windows, belonging to high and ancient buildings, some panes corroded, as if they had been worm-eaten; which seems to argue, that sharp and fretting particles had been carried thither by the winds whereto that glass was exposed. But none of the salts beforementioned have the faculty of corroding common glass. Other instances might be produced upon this occasion, but I reserve them for another treatise.

To discover
the salts in the
air.

The general method of discovering the salts in the air, may consist of several particulars. Thus, in the first place, it might be proper to lay open to the air, such bodies as have a disposition to be affected by the salt, wherewith 'tis most likely to abound. For instance, if we suspect the air to be impregnated with nitre, lime, or the like bodies, that imbibe or retain such a saltiness; died cloths or silks of such particular colours as will fade or tarnish with nitrous spirits, may be exposed thereto. Where vitriolic effluvia are supposed predominant, proper

proper preparations of sulphur shou'd be suspended, to try whether they will acquire a blackness. In other places, guesses might be made, by spreading on the clean ground, white linen cloth, well freed from sope or ly; and observing, after it has lain a considerable time, what discolouration it has suffer'd, and what saltness it has imbibed; either from the ascending steams, or falling dews. Another way is, to find some particular body capable of being affected by several aerial salts, in such different manners, as to discover which kind produced the respective changes. 'Tis doubtless difficult to obtain such a body, yet perhaps the thing is not impossible.

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Having caused some thin copper plates to be made clean, I kept them over glasses, filled with different spirits, as of common salt, and of nitre, both pure and diluted with water; whereupon I observed, tho' no heat was applied to the glasses, yet fretting particles ascended from the liquors in less than a day's time, when the spirits, just mentioned, had greatly darkened the under surface of the plates, by different discolourations; so that 'twas afterwards easie to see which was caused by the saline, and which by the nitrous effluvia.

Experiment 1.

Spirit of nitre, as I formerly found, makes, with copper, a greenish blue solution; spirit of salt, a grass green liquor; and the spirit of foot and urine, a deep blue, almost like ultramarine. But want of time hindered me from prosecuting these experiments; which might possibly have had a happy issue. And what farther keeps the thing from appearing desperate, is, that I have seen pieces of malleable copper, from an english mine, overcast here and there with a fair verdigrease, which appeared, by circumstances, to have proceeded from the corrosive effluvia of the air. Perhaps, also, there are other subterraneous or metalline bodies, that by the colour, peculiar rust, or stain they acquire in the air, may enable us to conjecture with what substances or salts the air of the place is impregnated. I knew a stately house which received this peculiar inconvenience from the effluvia of the air wherein 'twas seated, that the silver plate could not, by any means, be preserved from odd discolourations, tho' carefully kept in a convenient part of it. And in *Amsterdam*, I am told, plate tarnishes immediately, upon being exposed to the air; and contracts a dirty colour, betwixt a yellow and a black. A third way is, by the use of metalline bodies, chymically prepared, and previously reduced to fine parts, by means of saline substances. Here such bodies, or factitious minerals, are to be employed, as having, generally, an accidental colour, will change it in the air.

A strong solution of pure silver in *Aqua fortis*, precipitated with spirit of sea-salt, gives a white powder, which being exposed, for a considerable time, to the air, will acquire a dark colour on its surface, wherein an attentive eye may, perhaps, discern variations, as any particular saltness happens to predominate in the air.

Experiment 2.

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Experiment 3.

We mixed an equal weight of copper filings and powdered sal-amoniack together, and put them into a covered crucible, which was kept over a moderate fire, till the salt had done fuming; when all the remaining dark coloured mass that could be separated, being taken out, grossly bruised and exposed, for some time, to the air, it looked like a kind of verdigrease, a substance whose colour may be observed to vary according to the nature of the particular salts, which by corroding and incorporating with the copper, produce the pigment. But a parcel of the same mass being grossly powder'd, before the air could much affect it, and hermetically sealed up in a glass egg, and left in a south window, it did not appear discoloured, when the external surface of the other parcel resembled verdigrease; which argues the change of colour to have been made by the aerial salt, if the moisture of the air had no share therein, but as a kind of vehicle to the salt.

Experiment 4.

By pouring some spirit of wood-foot on filings of copper, I obtain'd a deep azure colour'd solution like ultramarine, which being suffered to dry in an open glass by the sole operation of the air, the colour presently became paler, resembling that of a good turquoise. The same success I, likewise, had with an urinous spirit, drawn from animal substances and copper filings.

To describe the above-mentioned changes more particularly, would have been so exceeding difficult, that I did not attempt it; for few, besides painters, can distinguish all the usual variety of colours by proper names. And besides, perhaps there are some that no language can express, especially when they have been attentively viewed and considered; tho' by a knowledge herein it might sometimes be ascertained what substances in the air are denoted by such variations.

It does not appear that our inland countries abound considerably with corrosive salts, since the bars and casements of windows will not thereby be greatly impaired by rust, after they have endured the weather for twenty years; whence I conjecture, that kind of salt proceeds from the sea vapours, or those raised by the burning of mineral coals.

" The pot being taken from the fire, and suffered to cool, is
 " emptied of its pure nitre, that resemble white marble; the terrestrial
 " part remaining at the bottom. The earth wherewith the solution was
 " made, and the boughs of oak, or the like trees, are then to be alternately
 " exposed to the air, and sprinkled with water, wherein nitre
 " has been dissolved; and by this means, in five or six years time, it
 " will be again fit for solution. The purer parts of the nitre thus
 " generated, as also that which hangs upon the walls in wine vaults,
 " is to be mixed and boiled with the first solution. But if any place
 " yield many of these veins, they should not immediately be laid up
 " in the reservoirs, but be first thrown on a heap in open spaces;
 " for the longer they lie exposed to the air and rain, the better
 " they

“ they grow ; and in four or five months after this, fibres will shoot
 “ out, which are much more excellent than the veins. If a separa-
 “ tion do not happen in the second boiling of the decoction, pour it
 “ out of the smaller vessels into the larger, and let it be shut up
 “ therein, when also the copperas will separate from the alum, and
 “ run into lumps ; but that which will not concrete in the vessels,
 “ should be boiled again, and the earth that stays behind thrown
 “ back into the reservatory, together with the veins, to be there afresh
 “ diluted with water and urine. The earth remaining in the reser-
 “ vatories after solution, becomes gradually more aluminous and
 “ juicy, as that whence nitre was made. ” *Agricola de re metallicâ.*

A learned physician, who practised in the most southern parts of the *English* colonies, told me, that the great guns there are so subject to rust, that after lying a few years in the open air, large cakes of *Crocus martis* may, with a hammer, be easily beat off them ; whilst others that lay sunk in salt-water, during the same time, were by no means so much affected. And as dew is only steams of the terrestrial globe, the phenomena that manifest its power to work on solid bodies, may help to shew how much the air abounds with saline and subtile parts. The dew about the maritime places of *Brazil*, and even part of the inland country, a scholar, who had been there, assured me, not only gave a rust to knives, and such like instruments, but also to coin. He added, that the *Portuguese* are there obliged to case their great guns, to prevent their being corroded by it, so as to break in discharging ; and that he often observed it left a pure, white salt, like a hoar-frost, on the grass and trees. Another ingenious physician informed me, that at *Fahlun* in *Sweden*, noted for one of the best copper mines of that kingdom, the mineral exhalations affect the air so, that their silver coin is frequently discoloured, and sometimes turned black thereby ; tho' close tied up in several purses, and lock'd up in strong chests. He said also, that these effluvia manifestly affected brass, and to that degree too, as to occasion seven crowns of that metal, reserved in one of their principal churches, to remain unclean'd, and perfectly black ; because they foul'd so fast, as render'd the trouble of keeping them bright almost endless. These corrosive exhalations, he farther aver'd, penetrate the bars and vessels of iron, that lie exposed to the air, so freely, that friable scales of rust may, at no long intervals, be easily obtain'd therefrom.

A *Neapolitan* nobleman acquainted me, that during his stay at a country-house near *Naples*, he used frequently to ride upon a very sulphureous soil, where, if his horse trod pretty hard, a great crackling noise would arise ; which, to a stranger, might have seem'd surprising, and dusty sulphureous fumes be raised, which seem'd ready to take fire, as sometimes he thought they actually did ; and having caused some turfs to be cut out of this ground, and laid together in a heap, he could, in the night time, sometimes observe the effluvia thence

*Sulphur in
the air.*

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thence plentifully arising to kindle in the air. The same honourable person likewise assured me, that in the late eruptions of mount *Vesuvius*, both he and others were greatly amazed at the prodigious height of the flame which shot up from that *Vulcano*; and that by means of a quadrant, they found it reach'd two miles above the top of the mountain. He added, that the adjacent earth would sometimes tremble, that vast stones and heavy bodies would be discharged, and that he himself had there seen fiery masses of matter thrown into the air, each of them capable of filling a large room.

"The island has a shocking appearance; the prospect from the port is the sea, and shore all black and burnt, by a small rock that first discovered it self about sixty years ago, vomiting out a prodigious flame at a cavern of an immense depth. 'Tis not above eighteen years since, on a Sunday night, that a terrible noise began at the port of *Santorini*, reaching even to *Chio*, distant therefrom above two hundred miles, which was suppos'd to proceed from the *Venetians* fighting with the *Turks*; but at length it was found to be caused by a fire underneath the port above-mentioned, which there cast up, from the bottom of the sea, quantities of pumice-stones, with a force and report as great as if they had been severally discharged from a canon. The air of *Santorini* was by this means so infected, that abundance of people were kill'd, and many lost their sight thereby, tho' they recover'd it in a few days afterwards. This infection spread it self as far as the preceding noise had reached; for even at *Chio* and *Smyrna* all the silver coin was changed red, both that in the pocket, and that lock'd up in chests; and the same happen'd to the silver chalices in the churches. The infection, however, vanished in a few days time, and the silver recover'd its native colour; but the pumice-stones that were thrown up, cover'd the *Archipelago* to such a degree, that for a considerable time, when particular winds blew, the port was block'd up with them; so that not the least vessel could pass, till way was made for it by their removal. And some scatter'd remains of them may be seen to this day in the *Mediterranean*. *Seneca* tells us, that *Santorini* is built upon mines of sulphur, which doubtless gave occasion to this fire." *Voyage de Levant*.

'Tis a common observation, that thunder produces in the air a strong smell of sulphur; and I remember being at a town near the lake of *Geneva*, when the thunder was so violent, as greatly to terrify the inhabitants, tho' they were accusom'd to its shocks; I heard many complaints the next day of a strong sulphureous scent, that particularly proved almost insufferable to the centinel who stood near the lake where the thunder fell.

"On July 24. 1681. The ship *Albermarl*, distant an hundred leagues from *Cape Cod*, in the latitude of 48°, about 3 in the afternoon, meeting with a thunder storm, the lightning burnt the main-top sail, split the main cap in pieces, and shiver'd the mast. One of the claps of thunder
" here

“ here proved excessively loud, whereat the whole ship’s crew were
 “ astonished; when something immediately fell from the clouds upon
 “ the stern of the ship-boat, which broke it into several pieces, split
 “ one of the pumps, and damaged the other. It seem’d to be a bitu-
 “ minous matter that caus’d this mischief, smelling like fired gun-
 “ powder, and continuing to burn in the stern of the boat till it was
 “ wholly consum’d; for they cou’d not extinguish it by water, and
 “ attempting to dissipate it with sticks. But, what is more extraordinary,
 “ when night came on, and the stars appear’d, they found their com-
 “ passes changed. That in the biddekel had its north point turned
 “ due south: one of the two others, which lay unhung in the locker
 “ in the cabin, pointed exactly as the former; but the north point
 “ of the third stood west. The polarity of their needles being thus
 “ changed, the sailors were for some time at a stand how to work
 “ their vessel; however, they afterwards sailed a thousand leagues
 “ in this manner. That compass whose needle thus came to point
 “ west, was brought to *New-England*, where the glass being broke, and
 “ the air gaining entrance, it lost its virtue. But one of the others
 “ is in that country possess’d by Mr. *Encrease Mather*; the north point
 “ of the needle remaining south to this day.”

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An eminent planter of trees, gave me part of a branch, with a fissure in the bark, that seem’d almost to reach the wood, from one end to the other; tho’ the lips of the wound were now grown over with new bark. The like hereto he observed in other branches of the same tree; and this, for several reasons, he could ascribe to nothing but lightning, which about that time had been very frequent; and many more trees, as well his own as those of others, far distant from the former, were affected in the same manner. These fissures looked not all one way, but respected several points of the compass; whence I am confirm’d in my solution of some odd phenomena of lightning, by comparing its irregular, winding motion, to that of a squib. However this strange kind of fire may affect animals, ’tis not always pernicious to vegetables; as appears from the just mention’d wounds it makes in trees, which happily cicatrize of themselves, without any farther damage.

Beginning to consider the properties of vinous liquors, their several distempers, and the method to preserve them, I found it previously necessary to make an exact scrutiny into the air, its qualities, temper, and motion; with the influence it has upon all such bodies. This led me into some thoughts, relating to the imperfection of our present theory of the planets. ’Tis certain, if this theory be not built upon a demonstrable foundation, differences and errors will happen in our opinions of the motions of the planets, and the calculations of their places. But if we err in this respect, their several aspects and influences cannot be justly determin’d; and consequently, the physical use of these celestial bodies is wholly lost, or becomes very uncertain.

Celestial influences in the air.

NAT. HIST.

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A new use  
of astronomy.

And truly, if astronomy cou'd not afford some assistance in ascertaining the affections, dispositions and alterations of several things here below, I should grutch all the time and cost; all the watchings and observations it requires. Several objections, indeed, are commonly produced, against any such use or application to be made of this science, and against the influence of the celestial bodies. But these chiefly proceed from the imposture and ignorance generally found in the professors of this science; the palpable mistakes, and great uncertainties as to predictions, under which it labours; and lastly, from want of knowing the manner wherein the celestial bodies may affect each other. Such objections, however, if thoroughly consider'd, do not, as I apprehend, make against the possibility of the thing, but wholly arise from the enormities and imperfections thereof; and these bodies may still have a power to cause such particular motions and alterations, as, in their extremes, will render themselves universally perceptible. And this appears by undeniable experiments, not only in vegetables, but in animals, and that both in acute and chronic distempers; more particularly in lunatic, epileptic, paralytic, or lethargic patients. This is further demonstrable, if the extreme motions in physics, be generation and corruption, and rarification and condensation the mean ones; for allowing these bodies a share in promoting the latter, their effects upon all other sublunary things must be very considerable. Generation and corruption are, properly speaking, the extremes of motion, rather than motions themselves; for the design and effects of all physical motion, are, in strictness, either generation or corruption; and all motion is hereby limited and bounded; for beyond these there is no physical progression; since all things are corrupted to be generated, and *vice versa*. It must then be acknowledged, that nature makes use of motions between these two extremes; which mean ones must also be as opposite to each other, as the two extremes. And as the motions of rarification and condensation are opposites, so they fall in with all the other instruments and phenomena of nature; the one corresponding to heat, the other to cold; the one to hardness, compactness and dryness; the other to softness, sweetness, maturity, &c. For these, among many other reasons, I conclude, that generation and corruption, rarification and condensation, are the simplest, plainest, and justest analysis, in nature, of all physical motions; since all motion purely physical, may, with ease, be immediately referr'd thereto, and resolved therein.

'Tis evident, that all the properties of moisture, heat, cold, droughts, winds, showers, thunder, &c. employ'd by nature to produce the two universal effects, rarification and condensation, almost wholly depend upon the course, motion, position, situation, or aspect of the celestial bodies. Thus every planet has its own proper light, distinct from that of the others; which is either a bare quality, and then its utmost use and design is only to illuminate; or else all light is attended with some pecu-



peculiar power, virtue, or tincture; whence 'tis plain, that every light has its peculiar property, tincture, and colour; its own specific virtue and power, wherein the planets differ from each other; and consequently the celestial bodies are not to be considered as sluggish and unorganized matter; but as full of their proper motion, operation, and life. Thus, the sun not only shines upon all the planets, but by his genial warmth calls forth, excites, and raises the motions, properties, and powers peculiar to them: whence, according to the angle they make with that grand luminary, and the degree wherein they are enlightened, either by its direct or oblique rays, in a near or remote situation in respect of the earth; the effects of the powers, virtues, and tinctures proper to each, must be more or less perceived by us. As for the manner wherein the planets transmit their powers, and thereby affect the remoter bodies, 'tis not difficult to apprehend it; for we affirm no virtue or power to flow from the planets, that comes not along with the light as a property thereof.

'Twas never imagin'd that any of the planetary or solar light is refracted, or otherwise weaken'd or diminished by the æther, thro' which it passes; and consequently 'tis not hinder'd from descending with its full force, directly and unrefracted, upon our atmosphere. But whatever is received by the atmosphere, must also be received by the thin and subtile air that is contiguous thereto; which air is, doubtless, capable of being moved, agitated, altered, and impressed by the properties, virtues, and lights that penetrate all its parts. Not only so, but our spirits also, with those of all mixed bodies, will receive no less impression, alteration, motion, agitation, and infection from the same lights; nay, as our spirits approach nearer to the nature of light than that of air, so will they be more affected thereby. And if the spirits, we speak of, may be altered, changed, moved and impressed by these superior bodies, and their properties; since such spirits are the only principles of action, power, force and life in the bodies, wherein they reside, and the immediate causes of all the alterations therein, 'tis impossible they should be altered and changed, and the respective bodies remain unaffected thereby; consequently the force of the superior bodies must exert a power or operation on the very substance of the inferior. To confirm this, in particular, with regard to our selves, we might have recourse to the mischiefs that frequently befall mankind by means of the air, which seems no otherwise concern'd; such are convulsions, cramps, blasts, lameness, colds, &c. many whereof have a long duration, tho' rarely felt at the very instant of their approach, or attended with any perceptible excess of heat or cold.

As the other planets, so also our earth is not only enlightened, warm'd, cherish'd, and made fruitful by the power, virtue, and influence of the sun; but it hath, moreover, its proper, magnetical, planetary force awaken'd, fermented, excited, and agitated; which it

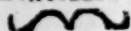
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sends back with the reflected light of that luminary. By this means also, the seminal dispositions, odours, and ferments, lodg'd in particular regions and parts hereof, at the same time emit and diffuse thro' the air either their kindly and grateful, or malignant, congealing, and putrefying qualities. Hence, tho' the temper, disposition, and general qualities of the air may be assigned according to the motions, influences, and aspects of the several superior planets, yet the particular healthfulness and unhealthfulness of places; the bad dispositions of the air, whether in the evenings, nights, or mornings; in some parts more than others; excessive moisture, great winds, droughts, or seasons peculiar to a country, should chiefly be ascribed to those odours, vapours, and exhalations, that by the action of the sun, or other planets, are forc'd from their particular seats in the planets themselves into the air. Now if this be the state of the case, it follows, that wholly to neglect such a physical use of the motion of these bodies, because superstition has crept into it, is very extravagant; and ought not to pass uncensur'd in men of learning.

In this apology for astrology, I, by no means, pretend to justify any thing farther than as it properly, or of necessity, falls under natural philosophy; but I greatly suspect, that if the theory of the planets were so well adjusted and settled, by demonstration, that we exactly knew the place, course, and position of every one of them; the doctrine of their physical use, with its weight, dignity, extent, and moment, would immediately become self-evident; especially if particular persons would calculate the motions here to their own respective meridians, and compare them with their own daily observations of the alteration of the air. As this was, doubtless, the method first taken by the antients, to discover the efficacy of these bodies, by giving an historical diary of the weather and places, motions and aspects of the planets, with their agreement, disagreement, &c. the same procedure could not but prove satisfactory and delightful in the momentous doctrine we speak of. And were such a plain demonstration of the power of these bodies, in general, once established, the usefulness of this science in civil and oeconomic affairs; in husbandry, gardening, and physic; and the share they have in producing many other very surprizing effects, would be easily discern'd and credited. The present age seems better furnished than was ever any preceeding one, to lay such a foundation by means of those extraordinary instruments the thermometer and barometer. And no man, who hath leisure and opportunity, should think it trifling to collect observations of this nature: 'tis certainly much more commendable to preserve this kind of history of our own time, than to break out upon every occasion; "This is the hottest, this is the coldest, this is the most seasonable, this is the most unseasonable weather I ever felt;" when perhaps it's utterly false in fact. Did no other benefit accrue from these observations, they would tend to complete the natural history of any place; an instance whereof

*The keeping  
diary of the  
weather re-  
commended.*

we



*The defects  
of the thermom-  
eter.*

we have in that learned author, who has given us the natural history of *Brazil*; wherein he proves not only the habitableness, but healthiness of the climate, by a particular account of the weather of every day, for many years together. 'Twould be a noble undertaking to promote the perfection of a set of accurate observations hereto relating, by means of various large and exact thermometers, conveniently exposed, either separately or conjointly, to the air. 'Tis greatly to be lamented, that no advantage has been made of this instrument since its first invention. Many things, indeed, are wanting to its perfection; for the best proportion between the diameter of the cylinder and that of its head, is hitherto unknown, which ought to be the first consideration here; and till this be adjusted, there is danger of erring in making either too large for the other; whence the alterations of the air will be too suddenly or too slowly discernable. But supposing the due proportion in this case assign'd, we are at a loss as to the length of the cylinder, which should, doubtless, correspond to its diameter; the smallest tube in proportion to its head, requiring the greater length, and *vice versa*; only twelve or sixteen degrees are usually placed on the ordinary glasses, but to make accurate observations, the cylinder should, at least, be divided into 360 parts: nor is it impracticable to divide one into 1000, allowing 10 degrees to an inch; and this would discover not only the minute, but the more sudden and remarkable changes of the weather, much better than those in common use. No liquor, 'tis certain, should be applied in these glasses that is subject to freeze, yet have we but a very imperfect account what fluids are best fitted for such experiments; whether those which attract the air, and thereby preserve their quantity, as *Oleum Sulphuris per campanam*, *Vitrioli*, *Tartari per deliquium*, &c. or those, the parts whereof are exceeding fine and subtle, and give them a resemblance to the air; such as spirit of wine, and spirit of turpentine well rectified, and supplied occasionally; whether those of a middle nature, as strong spirit of vinegar; or lastly, whether only well refined quicksilver. All these particulars must be settled as necessary preliminaries to the experiments themselves; in the making whereof 'tis convenient, that several glasses, alike in all respects, should be placed together in one frame, and filled either with the same or different liquors; and several of these frames placed in various rooms, and some expos'd immediately to the air it self; but skreened from the sun's rays and the injuries of the weather. Too great care and exactness cannot be used in the history it self; the air of the chimney, cracks in the wall, the breath of people, &c. if not regarded, will disturb these observations. The degrees of warmth of the day and night, in settled weather; the agreement or disagreement of the air's motion, and that of the superior bodies, in changeable and unconstant weather; the certainty or uncertainty of those motions, in foretelling winds and rain; the dispositions of the air in thunder, mildews, blasts, eclipses, conjunctions, &c. will afford matter for this history. What other



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'Tis an approved tradition in *Java*, that the moon's rays will cause contractions in the bodies of those who are long exposed thereto. And an ingenious physician, who had practised there, assured me, he observed some persons become lame by this means; and so continue for many weeks, or sometimes months together. He also experienced it upon himself; for happening, whilst he was a stranger in that country, to sleep, after a very hot day, for a considerable time on the ground, that lay fully exposed to the moon; upon waking he found his neck exceeding stiff, and his mouth drawn awry in an hideous manner; which obliged him to keep within doors, till by the use of brisk aromatic medicines, he freed himself from that disorder. The coldness of the night, and the subtilty of the air, he said, were not the sole cause of these phenomena; the effects of those generally proving lighter, if the moon be unconcern'd.

An intelligent person having by a fall so broken his head, that several large pieces of his skull were obliged to be taken out, he assured me, that for several months, during which he lay under the surgeon's hands, he constantly observed, that about full moon, there would be extraordinary prickings and shootings in the wounded parts of his head, as if the meninges were stretched, or pressed against the rugged parts of the broken skull; and this with so much pain, as would for 2 or 3 nights hinder his sleep, of which at all other times of the moon he used to enjoy a competency. This gentleman added, that his several surgeons, for he had 3 or 4 at once, observed from month to month, as well as he, the effect of the full moon upon his head; informing him, that they then manifestly perceived an expansion, or intumescence of his brain, which appear'd not at all at the new moon; nor was he then obnoxious to the forementioned pricking pains.

Motions of  
the air.

From a letter, dated *Fort St. George*, Jan. 23. 1668. " There happen'd  
" a dreadful storm, or rather hurricane here, on the 22<sup>d</sup> of *November*,  
" when a tempest of wind and rain grew so exceeding violent, that  
" nothing was able to stand against it. Men and beasts were thereby  
" swept away together into the sea; few houses or trees escaped its  
" force; the wall of the town was laid flat in several places; the  
" buildings about the fort were uncover'd and greatly shatter'd; and  
" the fort it self was so vehemently rock'd, that it seem'd ready to  
" fall upon us."

Captain

Captain *Brookehaven* told me, that hurricanes are very frequent about the island *Maufricius*; that he remembred one on the sea not far from thence, which lasted four days; that upon one of them the storm had seven paroxysms, call'd by the sailors, frights of weather, each whereof he observed to differ two points of the compass from the other successively; and that by this means the surface of the sea became a white froth. This storm occasion'd the day to be exceeding dark, and the noise it made seem'd more like that of thunder, than of wind; which was so loud, that those on the deck of the ship cou'd not hear those on the shrouds.

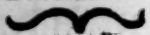
A physician who had been in *America*, assured me, that none but the hilly part thereof had constant winds from the land in the night time; and that, therefore, *Barbadoes* was without them.

One of the *East-India* committee, who had lived in the island of *Teneriff*, told me, he usually observed the breezes there to proceed from the sea, about nine of the clock in the morning; and that, two hours after the sun-set, there blew a sharp, land gale from every part of the island towards the sea, which continued all the night.

A learned traveller acquainted me, that tho' the air were generally calm and clear on the tops of the mountains; yet he had sometimes there met with winds considerably strong.

In a letter from *Venice*, dated *August 29<sup>th</sup> 1679*. " There arose  
" a kind of whirlwind in the fens of the city *di Favis*, three miles  
" distant from *Palma*; which spreading about 50 paces in breadth,  
" swept along with such fury, that it carried up into the air several  
" hay-makers in the neighbouring meadows, with loaden waggons,  
" horses, oxen, and all; casting 'em down a large distance off, shatter'd  
" and ruin'd. In its progress it tore up all the herbs and plants it met  
" with, and even pared, and burnt the turf. At its arrival in the  
" little *Venetian* town *Bagnaria*, it overturn'd several houses to the very  
" foundations, and uncover'd others; hurrying along with it beams,  
" pillars, tables, and all the furniture and moveables, and bruising  
" many persons, tho' without killing any. It stript the church  
" *S. Thomaso*, near the town, quite bare; carrying away the very  
" steeple and bells, which were not yet found the next day. Hence  
" it turn'd towards *Sevigliano*, where it destroy'd the whole cham-  
" paign, tho' without doing any damage to the town. A little far-  
" ther it threw down the palace of the Count *Horatio Strafoldo*, and  
" took away with it in the air various kinds of animals and moveables,  
" and even the very vessels out of the cellars: yet no body was hurt,  
" the family being most of them at work in the fields. In its way to  
" *Strafoldo* it threw down two other houses, killing therein a lady, a  
" young man, and several beasts. Hence turning towards *Palma*, and  
" arriving at the walls of the fort, on the side of the city *Privano*,  
" it beat it to pieces, overturn'd some very fine palaces, killing several  
" persons, and wounding others; and doing great mischief to the  
" grounds.

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“ grounds. It then advanced to the city *di Visco*, belonging to the  
 “ Emperor, where, among other considerable damages, it ruin’d the  
 “ new palace of *Marco Foscolini*, wherein was a large coach-house, the  
 “ door whereof was fasten’d by three bolts; but the wind entering  
 “ in at the balcony, burst open the door, shatter’d it to pieces, and  
 “ threw it upon a high court-wall, carrying the ceiling of the room  
 “ half a mile further; wounding some of the servants, and killing two  
 “ persons in the streets. This done, it attack’d *S. Vido di Crauglio*, a  
 “ town belonging to the Emperor, which it ruin’d entirely, so as  
 “ not to leave a single house; killing and wounding great numbers.  
 “ Hence it proceeded to *Villes*, a great part of which it levell’d with  
 “ the ground; destroying men and other animals, and leaving the fields  
 “ as bare as a beaten way. Other towns have suffer’d from it in a  
 “ like manner, tho’ in a less degree.”

I learnt from a physician, that tho’ the eastern winds blow near three quarters of a year at *Tangier*; yet they seem not to spread far into the inland country, because he found them there to be very unfrequent.

An ingenious gentleman, who possesses a mine or two near the sea, inform’d me, that he cou’d presage the change of wind, at the depth of between 15 and 20 fathom in ’em. For, many hours before it veer’d from any other point to the south, the water at the bottom of the mine would appear thick; and when ’twas upon changing to the east, the water became unusually clear.

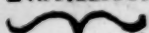
The hurricanes about *Goa*, as the same gentleman said, generally happen but at two seasons; viz. about the beginning of *March* and of *October*.

Prognostics  
 of hurricanes  
 at Bermudas.

The late governor of the *Bermudas* islands inform’d me, that these were of the principal forerunners, of the hurricanes there. The sea would manifestly swell at some distance from the shore, so that the fishermen often made to land, and warn’d the inhabitants, upon the confidence of that presage, to provide against the storm, tho’ the sea were then smooth enough. The sea would beat with great noise against the shore, especially the rocks, tho’ there appear’d no manifest cause for it, as upon account of the wind or tide: and this sign would sometimes not be given till many hours, or perhaps a full day after the former. Sometimes also ’twas observ’d, that the sea would suddenly invade the shore, and gain further upon it than could be accounted for by the wind or tide, and then quickly ebb away beyond the usual low water-mark, and after return again with more fury, and fall back further than before. Sometimes there would be perceiv’d an ungrateful smell in the air, before the hurricane began. And lastly, he affirm’d, that both he and others had seen in the air many bundles, as it were of long streaks of different colours; which by reason of their figure are usually there call’d horse-tails: and these appear’d in such parts of the sky, where the air was troubled indeed, but no form’d clouds were visible.

A





A gentleman told me, that being off the coast of *Mosambique*, towards the latter end of *September*, the captain of the great *Portugal* ship wherein they were, spied, as he walked upon deck, a very little dark cloud, or blackish spot in the sky, a great way off; upon which, tho' the weather was then fair, he immediately provided for a storm; and when the cloud approached, the wind, which before had filled their sails, ceased, and the sea became calmer than before; but presently after they had a furious hurricane, which several times turn'd their ship quite round; and lasted for above two hours.

"When several tempests rise together, the sky is of a sudden covered over with thick, black, globular and smoky clouds; when immediately the thunder bursts out on every side with incessant flashes of lightning, able to strike terror into the most resolute, and those accusom'd thereto." *Ludolf's Hist. of Ethiop.*

*The air's operation on the sounds of bodies.*

The string of a viol has by a gentleman been observed to increase the sharpness of its sound by almost half a note, either a little before, or in rainy weather. The same person also assured me, that having put false strings into his pocket for frets, he has sometimes, when he came to make use thereof, found them true. He further observes, that some strings are apter to receive a tension from the moist air than others.

An ingenious and credible person assured me, that in one of the fine gardens near *Genoa*, there is a pond on the side of a hill, where the wall being so high, that men could not look over it, nor be at all seen over it by the fish in the pond; yet that he has several times observed those fish to be called together by the gardener, with a certain noise he made for that purpose; tho' neither this gentleman, nor any one else, could be discover'd by the fish that readily obey'd the summons.

The different weight of the atmosphere at different times may perhaps have a considerable influence on the human body, with regard to health and sickness. Thus, when the air grows of a sudden much lighter than usual, the spirituous and aerial particles plentifully lodged in the blood, will naturally swell that liquor; and so distend the greater vessels, and alter the manner of the circulation thro' the capillary veins and arteries: whence several changes may happen in the body.

*The weight of the air, with its effects.*

Having three small, round glass bubbles, blown at the flame of a lamp about the size of hazel nuts, each of them with a short, slender stem; by means whereof they were so exactly poised in water, that a very small change of weight wou'd make them either emerge or sink; at a time, when the atmosphere was of a convenient weight, I put them into a wide mouth'd glass of common water, and leaving them in a quiet place, where they were frequently in my eye, I observed, that sometimes they would be at the top of the water, and remain there for several days, or perhaps weeks together; and some-

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times fall to the bottom; and after having continued there for some time, rise again. And tho' sometimes, especially if I removed the containing vessel to a south window, they wou'd rise or fall as the air was hot or cold; yet these motions were easily distinguishable from those produced by the varying gravity of the atmosphere. For when the sun-beams, or the heat of the ambient air, by rarifying the air included in the bubbles, caused that air to drive out some of the water, and consequently made them specifically lighter than water, tho' the bubble necessarily floated whilst the included air was thus rarified; yet when the absence of heat cooled, and consequently condensed the air, more water being intruded into the bubble, it must necessarily sink; and this wou'd commonly happen at night, if not before. But when the bubbles either rose or fell, by means of the different weight of the atmosphere, it appear'd, by the barometer, that the atmosphere was so heavy, or so light, as to be the cause thereof. So that I could often foretel the station of the mercury in that instrument, from the phenomena of these bubbles. And tho' whilst the atmosphere was not considerably either too light or heavy, the changes of the air, as to heat or cold, wou'd affect the bubbles, and make them often change places in the compass of a day; yet if the atmosphere were either very heavy or very light, the bubbles wou'd continue at the top, or the bottom of the water, for many days together; whilst the atmosphere did not change its gravity. And once, when the mercury stood high in the barometer, I set the glass for two or three days in a south window, about noon, in sun-shiny weather; yet even then the bubbles did not emerge; tho' it appear'd by a good sealed weather-glass, kept in the same window, that the ambient air was much warmer, than at other times, when the bubbles had rested on the top of the water. It being very difficult to poise several bubbles exactly, one as well as another, 'twas no surprize to me that all the three bubbles did not constantly rise and fall together. 'Twere, therefore, proper to poise a great number of bubbles together, that after trial made of all, the fittest might be chosen for this purpose. Sometimes a bubble that floated when first poised, wou'd after a while subside, without any manifest cause; or if made to sink by such a cause, wou'd continue at the bottom after that cause was removed; which seemed to depend upon the water's imbibing, as it were, certain aerial particles. The experiment, however, did sometimes answer expectation; which shews, that as the atmosphere is heavier or lighter, 'tis able to affect bodies under water; so that the air must press upon the water it self, by the intervention whereof it exercises its power; whence consequently the atmosphere is incumbent, as a heavy body, upon the terraqueous globe.

*A statical  
barometer.*

Making choice of a large, thin, and light glass bubble, blown at the flame of a lamp, I counterpoised it with a metalline weight, in a pair of scales that were suspended in a frame, and wou'd turn with the

the 30<sup>th</sup> part of a grain. Both the frame and balance were then placed near a good barometer, whence I might learn the present weight of the atmosphere; when, tho' the scales were unable to shew all the variations that appear'd in the mercurial barometer, yet they gave notice of those that alter'd the height of the mercury half a quarter of an inch; and if the scales had been more tender, and better accommodated, much smaller alterations might, doubtless, have been discern'd. By this means, however, the bubble did sometimes balance the weight, and sometimes this wou'd greatly preponderate; and that for different spaces of time, as the weight of the air continued. And thus the matter of fact was establish'd by repeated observations and comparisons, made with several of these new barometers together. The foundation of this invention is as follows. The glass bubble, and its counterpoise, tho' at first exactly of the same weight in air, are very different as to bulk; the bubble being perhaps two hundred times bigger than that. And if two bodies of equal gravity, in a certain medium, but of unequal bulk, be weigh'd in a different medium, they will no longer balance each other; if the new medium be the heavier, the larger body, because specifically lighter, will lose more of its weight than the less and more compact. But if the new medium be the lighter, the larger body will overbalance the less. And this difference arising from the change of the medium, will be proportionable to the inequality in the bulks of the originally equiponderant bodies. Hence it must prove the same thing, as to the effect, whether the bodies be weigh'd in mediums of different gravity, or in the same medium, whose specific gravity considerably alters.

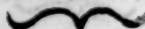
Since, therefore, it appears, by the barometer, that the air is sometimes heavier, and sometimes lighter, its alterations in this respect must unequally affect a large, hollow bubble, and a small, dense weight, once balanced in a pair of scales; so that when the air grows heavier, it must buoy up the glass more than the counterpoise; and when lighter, suffer that to preponderate. The glass bubble here employ'd was hermetically sealed; being equal in bulk to a large orange, and in weight one dram and ten grains. 'Tis possible to procure one more convenient than this, if care be taken not to seal it up whilst hot; for by that means the internal air being rarified, the glass will be easily broke by the force of the external. Two small bubbles, which are easily procured, may, upon occasion, serve instead of a large one, which it may prove difficult to obtain.

This instrument is improveable in several respects. A graduated arch of a circle might be fitted to the top of the balance, for the point of the cock to play in; and by that means readily give the angles from its perpendicular position. A gold weight may be substituted for one of brass. The several parts of the balance being made of copper or brass, will be less subject to rust than steel. Instead of scales, the bubble may



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be hung at one end of the beam, and the weight at the other. If the whole instrument, placed in a small frame, be included in a glass, open at the top, to admit a free passage to the air, 'twill be thereby preserved from rust and irregular agitations. A light wheel and an index would enable it to shew very minute variations. And, lastly, a proper length of beam, and an exquisite balance, may, alone, render this instrument far more exact than those I was reduced to employ. In some respects, indeed, the statical is inferior to the mercurial barometer; but in others it has peculiar advantages. As for instance, it first demonstrates to the eye, that the rise and fall of the quicksilver in the common sort, proceeds from the different weight of the atmosphere; for it cannot here be pretended, that an abhorrence of a vacuum, or a funicular power, is the cause of the variation. And 2. that the air is a more ponderous body than some learned men will allow. 3. 'Twill frequently be found more easily procurable than the other. 4. 'Tis very portable, and little liable to accidents, in removing it from one place to another. 5. Here is no uncertainty as to its goodness, as in the mercurial kind; where the air may be more or less excluded. 6. Both the absolute and respective weight of the air is hereby nearly discoverable; for 'tis easie to find hydrostatically the bulk of the bubble, and the contents of its cavity, with the weight and dimensions of the glass whereof 'tis composed; if the scales, therefore, be brought to an equilibrium, by small weights, when the mercury in the common barometer, is either very high, or very low, or else in a medium between both, observe when the quicksilver, either rises or falls, for instance, an inch, and then by adding weights to the ascending scale till the beam again becomes horizontal, you'll find what weight answers that determinate rise or fall of the mercury: and if the balance be furnished with a graduated arch, or a wheel and index, these observations may serve, for the future, readily to shew how much the bubble gains or loses by a change in the weight of the atmosphere. Some observations of this nature I carefully made, by adding a 64<sup>th</sup>, 32<sup>d</sup>, or a 16<sup>th</sup> of a grain to the lighter scale; but an accident hindered me from bringing them to perfection. 7. This instrument will farther assist us in comparing the mercurial barometers of several places, to make some estimate of the air's gravity there. For instance, suppose the bubble employ'd weighs just a dram, when the mercury stands at  $29\frac{1}{2}$  inches; and that the 16<sup>th</sup> part of a grain is required to reduce the bubble to an equilibrium, when the mercury rises an 8<sup>th</sup> above its former station. Suppose also, that removing my instrument to another barometer, equally freed from air with the former, when, if the bubble here retains the weight of a dram, and the mercury stands at  $29\frac{1}{2}$  inches, we may conclude, that the weight of the atmosphere is the same at both places; how remote soever they may be. But in case there be no barometer at this latter place, yet if, by the 16<sup>th</sup> part of a grain ad-



added to the bubble, I bring the scale to an equilibrium, 'tis plain, that the air here is, at this time, so much heavier than that of the former place, when the mercury stood at  $29\frac{1}{2}$  inches. But in such comparisons regard must be had to the situation of the places, if we would estimate the weight and density of the air. For tho' this instrument will shew a difference of weight in the atmosphere of two places, yet if one be a vale, and the other a hill, 'tis not to be expected that the atmosphere on the latter, should gravitate equally with that in the former, whereon a higher column of air is incumbent; and so the bubble have the same weight in both. The last use I shall mention of this statical barometer is, its serving to find the difference of the air's weight at several heights. Thus, for instance, having exactly poised the bubble at the foot of a hill or steeple, and afterwards raising the frame to the top thereof, the weight there requisite to reduce the beam to an horizontal position, gives the difference required. But how far this method may assist in estimating the absolute and comparative height of mountains, &c. and what other applications may be made of the instrument, when duly improved, I leave to farther consideration.

*Observations  
and directions  
relating to the  
barometer.*

It will be very convenient, that observers give notice of the situation of the place, where their barometers stand, not only, because it will assist men to judge, whether the instruments were duly perfected, but principally, because, that though the barometer be good, the observations will much disagree, even when the atmosphere is in the same state, as to weight, if one of the instruments stand in a considerably higher part of the country than the other.

To confirm the foregoing admonition, I may say, that having two lodgings, the one at *Oxford*, which stands in a bottom by the *Thames* side, and the other at a place four miles thence, seated upon a moderate hill, I found by comparing two barometers that I made, the one at *Oxford*, the other at *Stanton St. Johns*, that, though the former be very good, and hath been noted for such, during some years, and the latter very carefully fill'd; yet by reason, that in the higher place, the incumbent part of the atmosphere must be lighter, than in the lower, there is almost always between two and three eighths of an inch difference betwixt them: and having sometimes ordered my servants to take notice of the disparity, and divers times carefully observed it my self, when I passed to and fro between *Oxford* and *Stanton*, I generally found, that the *Oxford* barometer and the other, did, as it were by common consent, rise and fall together so, that in the former the mercury was usually  $\frac{1}{8}$  higher than in the latter. These observations may teach us, that the subterraneous steams which ascend into the air, or the other causes of the varying weight of the atmosphere, do many times, and at least in some places, uniformly enough affect the air to a greater height than, till I had made this tryal, I durst conclude.

But

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But as most of the barometrical observations are subject to exceptions, so I found the forementioned to be. For (to omit lesser variations) riding one evening from *Oxford* to *Stanton*, and having before I took horse look'd on the barometer in the former of these two places, I was somewhat surprized, to find at my coming to the latter, that in places no farther distant, and notwithstanding the shortness of the time (which was but an hour and half, if so much) the barometer at *Stanton* was short of its usual distance from the other near a quarter of an inch; though the weather being fair and calm, there appeared nothing of manifest change in the air, to which I could ascribe so great a variation; and tho', also, since that time the mercury in the two instruments hath, for the most part, proceeded to rise and fall as before.

The quicksilver has been of late, for the most part, so high, as to invite me to take notice of it, and about *March 12. 166 $\frac{7}{8}$*  at *Oxford* the quicksilver was higher than, for ought I know, has been yet observed in *England*, viz. above  $\frac{1}{16}$  above 30 inches; but upon the first considerable showers, that have interrupted our long drought; as I foretold several hours before, that the quicksilver would be very low, (a blustering wind concurring with the rain) so I found it at *Stanton* to fall  $\frac{3}{8}$  beneath 29 inches.

It is difficult enough to settle any general rule about the rising and falling of the quicksilver; yet in these parts one of those that seem to hold ofteneft is, that when high winds blow, the mercury is the lower; and yet that it self does sometimes fail. \*

The weight  
of a cubic inch  
of water, and  
of quicksilver.

Having procured an exact, concave, cubic inch of brass, and carefully balanced it in a nice pair of scales, by eleven drams one grain and a half, troy-weight, it was cautiously filled with clear, pump water, till the surface thereof appeared level with the upper edges of the metal; then weighing the water, it equall'd 254  $\frac{7}{16}$  grains; we may therefore, without any sensible error, suppose a cubic inch of water to weigh 256 grains; which agrees very well with some other experiments I made to discover the same. The metalline cube was afterwards dried and counterpoised afresh, and filled as exactly as possible with distill'd mercury; the weight whereof, alone, we found to be seven ounces, two drams, troy; but by adding a little, without making it run over, the whole inch of mercury equall'd seven ounces, three

\* 'Tis found that the mercury in the barometer descends upon violent gusts of wind; and Mr. *Hauksbee*, to solve the phenomenon, contriv'd an experiment, wherein an artificial blast of air so lessened the pressure of the atmosphere, upon the stagnant mercury in the cisterns of two barometers at once, that the columns sustained, were thereby made to descend two inches; tho' one of the barometers was di-

stant three feet from the stream of air. And hence 'tis very obvious, as Mr. *Hauksbee* observes, "that different forces and different directions of the wind, may produce different degrees of subsiding in the barometer; and that strong winds may, by thus altering the pressure of air, greatly affect the animal economy." *Hauksbee's Experim.* p. 114—119.

drams,



drams, twenty two grains. The eye now placed in a level with the brims of the vessel, discover'd the mercury a little above them; however, it still received 112 grains more of mercury, without running over; and more, perhaps, might have still been added. From hence it appears scarce possible to determine by this means, the exact weight of a cubic inch of quicksilver. And since by other trials I have found the weight of mercury to that of water, of the same bulk, in a somewhat less proportion than of 14 to 1; the weight of a cubic inch of quicksilver may well enough be supposed 3580 grains; and consequently, when a column of quicksilver, thirty inches high, is sustain'd in the barometer, as it frequently happens, a column of air that presses upon an inch square near the surface of the earth, must weigh above fifteen averdupoize pounds.

*What quantity of air presses upon a square inch.*

As 355 to 452, so is the area of a square inscribed in a circle, to that of the circle circumscribed; whence  $355.452 :: 1.1, 2732394$ . If, therefore, the side of an inscribed square be an inch, that square multiplied by another inch, gives an inch in solid measure. Thus if a cylinder, an inch in height, be erected upon the circle circumscribed; the solid content thereof will be 1,2732394. Hence 1, and 1,2732394, being multiplied by the weight of a cubic inch of any metal, you have the weight of a cubic inch, and of a cylindrical one that circumscribes the same; whence an inch table for both is easily made, by continual addition, or for any given height, if you multiply both thereby.

Fig. 2.

" The syphon B O, was sealed at the end O, but open at B; the  
 " bend from G to C containing mercury, and the other parts no-  
 " thing but air. The distance from O to C was four inches, or  $\frac{1}{8}$ .  
 " By heating the air, the mercury sunk to F,  $\frac{1}{8}$  lower than it stood  
 " before, and at the same time rose in the other leg to H,  $\frac{1}{8}$  higher  
 " than G or C. To find what height of mercury was required to  
 " hinder the expansion of the air, and continue the mercury at C,  
 " we need only try how much wou'd serve to force it back again  
 " to C; and thereby retain the air in the space O C, notwithstanding  
 " the force of the heat. I suppose it known from experience,  
 " that when a quantity of air possesses any space, which we call A,  
 " and the force, B, that retains it therein, be increased in any degree,  
 " suppose it X, the space A will be thereby diminish'd in a certain  
 " quantity D, which is to the remainder M, as X to B, thus,  $D.M ::$   
 " X. B. and consequently  $M.D :: B.X$ . This rule may be easily ap-  
 " plied to our present experiment; for herein O F,  $\frac{1}{8}$  inch, is the  
 " space A; and the usual pressure of the air, equal to thirty inches of  
 " mercury, added to the one inch between F and H, answers to B and  
 " X, or thirty one inches of mercury; and if a proper quantity be  
 " added to reduce the air into the space O C, the same O C, will be  
 " M,  $\frac{1}{8}$  and F C, be D,  $\frac{1}{8}$ ; whence the three quantities  $\frac{M.D :: B.}{32.3 :: 31.}$  are  
 " given

NAT. HIST. " given to find a fourth proportional,  $2\frac{1}{2}$  which added to B, 31, make  $33\frac{1}{2}$  inches, whereby the air is forced into CO, that is, near 4 inches more than the ordinary pressure."

" A sufficient number of exact surveying chains, being fix'd to a well-purged barometer, conveniently framed; the mercury standing at 30 inches and 50 cents; we drew it up to the first floor of *Sarum* steeple, 1033  $\frac{1}{2}$  inches from the pavement, when the quicksilver was sunk 9 cents; then raising it to the middle floor, that is, 935 inches above the former, it fell 8 cents lower; and when arrived at the weather door, that is, 2313 inches still higher, it subsided 23 cents more. The whole height was therefore 4281  $\frac{1}{2}$  inches, and the whole difference of the mercury's sinking, 40 cents of an inch. Upon letting down the barometer to the same places, the quicksilver severally rose to its former stations."

Fig. 3.

" At another time we used an inverted barometer in the like manner; when the fluid of it rose therein as follows.

|                  | Inches             |                     | Inches | Cent. |
|------------------|--------------------|---------------------|--------|-------|
| At the height of | 1033 $\frac{1}{2}$ | The liquor ascended | 1      | 25    |
|                  | 1968               |                     | 2      | 39    |
|                  | 2467               |                     | 3      | 22    |
|                  | 4281               |                     | 5      | 64    |
|                  | 4800 or the top.   |                     | 6      | 40    |

At a place on the great continent of *Europe*, but not far distant from the ocean, a learned acquaintance of mine lately observ'd the mercury in his barometer, the weather being calm and ordinary, to rise suddenly above two inches higher than the usual standard; which phenomenon was, in a few hours, followed by a prodigious and destructive storm, that blew from off the continent. The same gentleman observes, that when storms here blow from the sea, which lies to the southward, the quicksilver sinks considerably; as hath also been observed in *England*, by an ingenious person, who lives near two leagues from the sea. One whom I bred up to chymistry, was a few days since, surprized, to find the mercury in his barometer at *Oxford*, sink on a sudden greatly, while the weather continued fair and warm. The day, in four or five hours after, was overcast, and there happen'd a dreadful storm of rain, lightning, and thunder; with such a strong whirlwind as had scarce ever been remembered in that city.

In a letter from Mr. *Locke*. " The deepest gruffs or pits I could hear of at *Minedeep*, were about 30 fathom, but the descent into them is so exceeding difficult, dangerous, and impracticable to a stranger, that I durst not then attempt to go down with a barometer; for they are not sunk like wells perpendicularly, but as the cranies of the rocks happen to run. The constant method is, to swing down by a rope placed under the arm, and clamber along by applying both

" feet

“ feet and hands to the sides of the narrow passage. When damps  
 “ happen herein, if the miners cannot get out, they soon faint and die:  
 “ but if they be seasonably drawn up, a hole being dug in the  
 “ ground, their faces are placed therein, and covered close up with  
 “ turfs; which is the surest method they have hitherto found to re-  
 “ cover them. After the use of fire in their pits, they find it very  
 “ dangerous to descend, as long as any heat remains in the clefts of  
 “ the rocks. Air is convey’d into them thro’ a little passage that  
 “ runs along the sides from the top; where they set up some turfs  
 “ on the lee side of the hole to catch and force it down. These turfs  
 “ being removed to the windy side, or laid over the mouth of the  
 “ hole, the miners below presently want breath, are indisposed, and  
 “ faint: and if sweet flowers chance to be there, they immediately  
 “ lose their fragrancý, and stink like carrion. Being unable at this  
 “ time, to make any experiment with the barometer in these gruffs,  
 “ I carried it to the top of a high hill adjoining; when the mercury,  
 “ which below stood at  $29\frac{1}{8}$  inches, was now sunk to  $28\frac{1}{4}$  inches. In  
 “ ascending and descending, I found the quicksilver to fall and rise  
 “ proportionably to the height where I stood. But at my return to  
 “ the foot of the hill, it wanted  $\frac{1}{32}$  inch of the station it there had  
 “ before; which I impute to the rarification of the air remaining in  
 “ the upper part of the tube.”

The king was lately pleased to tell me, that taking water from  
*Whitehall*, to sail towards the river’s mouth, in exceeding fine weather;  
 upon which being congratulated by the courtiers, his majesty bid them  
 prepare for a storm; which, in a few hours, happen’d accordingly;  
 and drove vehemently upon the yatch for several leagues together.  
 The king, before he went on board, had privately observed the  
 mercury in a good barometer, to sink very remarkably.

“ Since the water in pumps, and the external air, mutually balance  
 “ each other, they must have the same weight; whence if the height  
 “ whereto water rises in any part of the world be known, by what  
 “ weight of the incumbent air that part is pressed, will be known  
 “ also; and therefore, the places by the sea side are pressed by the  
 “ weight of the whole incumbent atmosphere, as much as they wou’d  
 “ by a column of water 31 feet 2 inches high; those that rise ten  
 “ fathom above the former, as much as if they sustain’d one of 31 feet,  
 “ 1 inch; and those that lie 500 fathom higher than the sea, are  
 “ pressed as by a column of water of 26 feet, 11 inches, &c. Hence  
 “ it appears, that the air which stands above the level of the sea, is  
 “ equal in weight to water 31 feet, 2 inches high: but because air is  
 “ lighter upon places above that level, and therefore presses not all  
 “ the points of the earth equally; and being also of different weights  
 “ in different places, there is no certain rule to determine the exact  
 “ quantity of air, whereby, one with another, all the parts of the world  
 “ are pressed. This, however, may be tolerably done in a conjectural  
 Vol. III. H “ way;



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“ way ; for example, by supposing, that if all the parts of the earth  
 “ were equally pressed with air, 'twou'd be the same as if they sup-  
 “ ported water to the height of 31 feet ; and 'tis certain we cannot  
 “ err half a foot in this supposition. But we have seen, that the air,  
 “ at the height of 500 fathoms above the surface of the sea, is equal  
 “ in weight, to water 26 feet, 11 inches high ; and consequently, the  
 “ air, from the surface of the sea to that height, weighs as much as  
 “ water of 4 feet and an inch high ; that is, near a seventh of the  
 “ whole height ; whence 'tis plain, that the air between the sea and  
 “ the same height, is nearly a seventh part of the whole atmosphere.

“ 'Tis known also, that the vapours collected in the air, weigh,  
 “ when most numerous, no more than water of a foot and eight inches  
 “ high ; since that additional height of water will balance them in  
 “ pumps : so that were all the vapours that hang over a whole  
 “ country to descend in rain, they would only make that quantity of  
 “ water ; for if more happens to fall, it's owing to the winds driving  
 “ the vapours thither from other parts. Hence, likewise, it appears,  
 “ that if the whole atmosphere was pressed against the surface of the  
 “ earth, by a force applied to its upper surface, and thereby reduced  
 “ to the density of water, 'twou'd then be no more than 31 feet in  
 “ height. The atmosphere, therefore, in its free state, may be con-  
 “ sider'd as if it had once been water, covering the earth, to the  
 “ height of 31 feet ; but afterwards exceedingly rarified, expanded,  
 “ and converted into what we call air ; tho', in fact, it possesses a  
 “ larger space, but has not a greater weight than water of the height  
 “ of 31 feet. Now, 'tis exceeding easy to compute, what quantity of  
 “ water wou'd every way surround the earth to that height ; which  
 “ gives the whole weight of the air. For, since a cubic foot of water  
 “ weighs 72 pounds, a prism thereof, (to use that for the sector of a  
 “ sphere) whose base is a foot square, and height 31 feet, will weigh  
 “ 2232 pounds ; and since the surface of the earth contains  
 “ 3711.420000.000000 square feet, the product of these two sums,  
 “ which is 8.283889.440000.000000 pounds, gives the quantity of wa-  
 “ ter, and consequently the quantity of air required.”

Fig. 4.

“ To render the weight of the air sensible, I caused a very light,  
 “ glass bubble, AB, to be blown retort-fashion, about the bigness of  
 “ a common ball, with the aperture B, capable only of admitting an  
 “ hair ; and finding, by a very tender balance, its weight to be  $78\frac{1}{2}$   
 “ grains when cold ; I heated it, and placed it again in the scale upon  
 “ its end B, when it scarce weigh'd 78 grains ; then plunging its  
 “ orifice into water, whilst the glass cool'd, and the contain'd air  
 “ condensed ; as much water enter'd into it, as air had been forced out  
 “ by the heat. Coming now to weigh the bubble again, I found it had  
 “ gain'd  $72\frac{1}{2}$  grains ; whence I supposed the air expell'd by the heat,  
 “ was to the water that came in its place, as  $\frac{1}{2}$  to  $72\frac{1}{2}$ , or as 1 to  
 “ 145 ; and tho' this cannot hence be determin'd with exactness, yet,

“ at

"at least, the experiment shews the weight of the air to be sensible." NAT. HIST.  
M. Paschal.

A thin large bladder, wherein remained only a third of the air, 'twas capable of containing, being firmly tied at the neck, suspended thereat, and fixed, by its lower end, to a fourteen pound weight that rested on the floor, but so, that the strings employed being well stretched before hand, would, if contracted even less than the quarter of an inch, draw up the same; we placed fire at some distance therefrom, by means whereof the air expanded, swell'd the bladder, shortened the whole string, raised the weight, and made it swing like a pendulum. We attempted twice or thrice to repeat the experiment with a quarter of a hundred weight, and a large bladder, but did not succeed; the bladder either soon leaking or bursting; tho' we proceeded so far, in one of these trials, as to gain hopes of thus sustaining a large weight.

In order to find whether the particles of the air would sink into a liquor exposed to its natural pressure, we strewed copper filings over the bottom of a cylindrical vial, and poured thereon an urinous spirit to a considerable height; covering the surface of the liquor with oil of almonds, to the thickness of the fifth of an inch; when the vial was close stopped up, and left in a quiet place for several days: during which the urinous spirit first slowly acquired, and then as slowly lost a blue tincture. When this colour was almost gone, we unstopped the vial, and kept it so for a minute, and then closed it again; when the upper part of the spirit began to be tinged blue, and within an hour after, tho' the vessel during that time was stopped, a sky colour reach'd to the lower part of the fluid, and which, at present, is wholly blue; the oil at the top remaining clear.

The best informations, I could any ways gain, have inclined me to think, that the common school-doctrine about the limits and temper of three regions in the air, however plausible, wants a just foundation. A physician, who lately came from *Morocco*, told me, that, notwithstanding the excessive heat in the day-time, the nights and the air upon the mountains, were there exceeding cold. Another gentleman, who made some stay at *Guinea*, assured me, tho' the heat of the climate be prodigious, he frequently, about four a clock in the morning, was ready to shake with cold, in his hammock, for an hour together. A learned person, who lived at *Jamaica*, informed me, that, lying in his hammock, three or four feet from the ground, with many clothes underneath, but few to cover him, he felt it cold below, and hot above. 'Tis obvious, that the heat of our air in summer has considerable effects on liquors, and the fluids of animals and vegetables; but that it shou'd, in the shade, sensibly rarify and expand so compact a body as glass, seems almost incredible; yet this effect appears probable from glasses well fitted with ground stopples of the same material, which are easily open'd in the colder seasons; but in the hot ones, I have found the strength of a man insufficient for that purpose;

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pose; so that I have been frequently obliged to plunge the necks of such vials in cold water, that the glais might shrink, and allow the stopples to be disjoin'd.

The effects of the summer's heat, tho' usually attributed to the bare warmth of the air, and the agitations thereby produced in our bodies, may, perhaps, sometimes proceed from the effluvia it excites in unregarded substances. To illustrate and confirm this assertion, I might alledge the placing of a large piece of fine amber, on a summer's day, when the sun was a considerable height above the horizon, in the shaded part of a window, and there permitting it to remain for some time, I could find no signs of an attractive power therein; but upon removing it to a part of the same window whereto the sun's rays had free access, it presently emitted effluvia, and readily attracted those lighter bodies it would not stir before: but this faculty it soon lost, by placing it again in the shaded part of the window.

The governor of *Hudson's Bay* inform'd me, that when the sailors come within a certain distance of floating islands of ice, and the wind blows therefrom towards the ship, they know, by the greater degree of cold they feel, that such ice lies to the windward of them; and sometimes before 'tis visible, or whilst 'tis distant about fifteen miles from the ship. The wind, he observed, at such times, usually brings a fog along with it; which, he supposed, comes from the ice. The same gentleman said, that where he winter'd in *Hudson's Bay*, the rivers began to freeze about the beginning of *November*, and were seldom free from ice till towards the latter end of *May*; tho' *Charleton Island*, lying at the bottom of the bay, has nearly the same latitude with *London*. It seems they are here obliged, in the winter season, to dig six feet deep in ice, to come at the unfrozen water of the rivers. Brandy frequently freezes in this country; when a fourth of it is turn'd to ice, whilst the unfrozen part remains exceeding strong and fiery. The ice, which here floats on the sea, is fresh, and serves, when thawed, for common water. Lastly, my relator added, that they often find large quantities of the liquor in cavities of the floating masses, made by the action of the sun thereon. A learned traveller often observed, during his aboad upon the *Pyrenean* mountains, that the air at the top thereof was very hot, tho' within a few hours after they would be covered with snow; and that too in the summer season. A physician declared to me, that the winds he felt at *Morocco* almost stifled him, and seemed like steams coming from the mouth of an oven. The *Russian* emperor's physician declared to me, that at *Archangel*, a northerly wind, coming from the sea, in the winter season, produces a thaw; but that a north-east wind increases the frost; and on the contrary, that a southerly wind, which blows over, perhaps, a thousand miles of frozen land, rather augments, than diminishes the same.

An inquisitive person, who had also visited the *Pyreneans*, declared, that both he and his company had sometimes observed, from the higher



higher parts thereof, thick clouds surrounding the hill, at a considerable distance below them; which produced storms of rain, on the lower ground, whilst they enjoy'd fair weather above; but when it thunder'd, they saw the lightning issue out of those clouds, and shoot upwards, as we generally observe it to do downwards.

Dr. *Stubbs* informed me, that he usually found at *Jamaica*, the water in a bolt-head, two feet and a half long, rose in the neck, about the same time of the day, that is between seven and eight a clock in the morning,  $\frac{1}{8}$  inch; the heat at that time, by reason of the winds, being very supportable; that when the sun had passed the meridian, the water gradually subsided till the same time next morning; and that tho' the glass stood naked and unstopped in a south window, whereto the fresh winds had a free access, the water therein did not sensibly decrease in eight or ten months time. A careful observer, who frequented *Sumatra*, told me, he had never found ice or snow, but great quantities of hail, in that torrid climate. The island *Ceylon* lies near the middle of the torrid Zone; yet one who passed many years upon it, assured me, that on hills there, where the height might be gain'd in half an hour, the temper of the air, as to heat and cold, is so unequal, that tho' it were vehemently hot at the bottom, he found the cold gradually increase as he ascended, till it became excessive at the top. In the inland part of the same island, captain *Knox* inform'd me, that during the eighteen years he spent there, he never observed any ice or snow, only a small kind of meteor betwixt dew and hoar-frost, which sometimes, in the winter mornings, appeared very oddly; but soon vanished. Hail, he never saw there but once, and then the inhabitants were surprized at the novelty. It was large, as a black cherry, not very round, and seem'd to have its corners melted; upon biting, he found it hard and cold, like *European* hail, but it melted upon the ground, in an instant.

"The winter in *Suaquena* would be thought exceeding hot, but in summer, the body is then excoriated; hard *Indian* wax is melted, tho' locked up in cabinets, and the shoes of the feet are sear'd by heat, as it were, with a red hot iron. The higher you ascend up the mountains of *Aethiopia*, from the red sea, the more temperate is the air; so that, at length, the summer heats are as mild here as in *Portugal*. Nay, there are some mountainous places in this country, wherein the cold is more violent than the heat; tho' there falls no snow in these parts, only a small kind of hail, sometimes, which resembles it." *Ludol. Hist. Aethiop.*

The *English* consul at *Tripoli*, in *Barbary*, inform'd me, that where the wind, in the summer, blows over the great sandy deserts there, both that and the sand that is brought along with it, are felt as hot as the steams from an heated oven.

A gentleman, employed in the *French* colony, on the coast of *Afric*, told me, that near the island of *St. Louis*, when, at a certain season

of

**NAT. HIST.** of the year, the hot winds blow from the continent, the sand on the shore is so scorching hot, as thro' their shoes to burn the feet of those who slowly walk thereon; at which times the air seem'd to him hot and heavy, as if it came from an oven: and when the wind, he said, blew thither from a certain wood, wherein many elephants and other wild beasts lay dead; the air, by the effluvia of their carcases, became intolerably fetid.

"On the top of mount *Ida* stands a little chappel, made up of loose stones, which, notwithstanding the great height of the place, are, some of them, now and then blown down by high winds. The air in the hottest part of summer is here exceeding cold, tho' not a breath of wind be stirring; the hills are therefore uninhabited both winter and summer; for the shepherds lie in the vales by night, where the summers are violent hot, whilst the top of the mountain is cover'd with snow." *Bellonius*.

"In my ascent to the top of mount *Venus*, the air proved very clear during the whole day; but when I was got up, I saw clouds under me about the middle of the mountain, which intercepted my view of the valleys. Coming down in the evening, I found much rain had that day fal'n below; tho' nothing like it had happen'd above. 'twas in summer I went up, yet perceived no great difference in the air all the time, as to heat and cold. *Bartholin* relates the same of the *Alps*." *Zabarell. de region. aëris*.

A physician told me, he saw mount *Atlas* from *Morocco*, cover'd with snow in the heat of summer. And the like hath been severally affirm'd to me, by travellers, of the *Alps*, where the wind has been found exceeding sharp; of the pike of *Teneriff*, of mountains in *Barbary*, in the island *Ceylon*, and of *Congo*; tho' snow be a stranger to the valleys hereto adjoining.

An Experi-  
ment.

About midsummer 1688, I placed a thermometer in a cave, where the spirit stood half a small division above temperate; whilst another in a common room was risen to hot: in the christmas following, the same glasses being set in their respective places, that in the cave stood as before, but that in the room, at frost. The cave was cut strait into the bottom of a clift, fronting the sea, to the depth of 130 feet, with 80 feet of earth above it.

I am inform'd by two gentlemen of the province of new *Hampshire* in *New-England*, that both the coldest wind of that country in the winter, and the hottest in the summer, is the north-west; which they ascribed to the large tract of continent, and the large woods that lie to that point of the compass; for these woods, they said, are laden with snow in the winter; and in summer, the close air of the vallies, and the thick exhalations wherewith it is loaded, conceive an intense heat, and often breathe in a sudden gust like the suffocating steam of a furnace.

"On

“ On one side of the mountains of *Bavaria* 'tis winter, and on the other summer, at the same time; so that while this side is parch'd with heat, that lies buried in snow.” *Balbin. Hist. Bohem.*

A gentleman, who had frequently descended into the gold mines at *Cremnitz* in *Hungary*, told me, that in his ascent out of one, which was an hundred feet deep, he observed the air about the middle to grow sensibly warm, and so to continue while he was drawn many feet higher; when at length it became cold again. This heat he suspected might proceed from some mineral region thro' which he passed; for he there found himself surrounded by a vein of native vitriol of different colours, and soft in the pit, tho' it soon harden'd in the open air.

An experienced person, who had sometimes crossed the line, acquainted me, that the method of cooling liquors on board their ship, so as to make them potable in sultry climates, was to wrap up the bottle wherein it was contain'd, in a coarse linen cloth dipp'd in sea-water, and thus expose it, in a proper place, to the wind; which wou'd soon reduce it to the state desired: but if the bottle, said he, be taken away too soon, as it sometimes happen'd with us, we found, so much of the liquor as lay near the sides thereof grown cool, while the more central parts continued hot.

The *Czar's* chief physician inform'd me, that in the year 1664, many large tracts of dry land were set on fire, and miserably wasted, by the heat of the sun. The like, in particular, he said, happen'd the last year at *Bearhaven* in *Norway*, where several wood-houses were also consumed. This was confirm'd to him by the governor of the place; and he himself saw the country cover'd with new grass, in the room of what was thus destroy'd. A learned traveller declared to me, that the inhabitants of *Mozambique*, judg'd the hottest part of the known world, had shewn him several houses which were there fired by the sole force of the sun. Their houses, indeed, are built with stone, wherein is mixed something like to *Sulphur vivum*; but I my self, says he, have often seen the hollows of stones so heated by the sun, that musket bullets expos'd to its direct rays therein, were by that means alone soon melted. He added, that great part of the heat of *Mozambique*, is owing to the soil, which is exceeding bare, and consists of white sand, neither shaded with trees, nor cover'd with grass. Another traveller, who had been here, assured me, the heat of the ground was so violent, that he was obliged to keep in constant motion, to avoid burning the soles of his feet.

“ Bridges of snow have been observed upon the *Pyreneans*, to reach from one rock to another, and to give passage to the torrents underneath them. My friend saw one, which thus serves for two streams; it was 29 furlongs in length, and as much in breadth at the top. These bridges seem strong enough to allow a passage for canon.

“ The



" The cold was so excessive in the year 753, that it froze the *Euxine* sea an hundred miles in length, as well as the neighbouring ocean, to the depth of 30 cubits; this happen'd too at the beginning of autumn." *Journal de Savans.*

In *Guinea*, as I am inform'd by one who lived there, they keep their water cool, by burying it over-night in long earthen jars, a little below the surface of the earth. By this means it becomes potable, with some tolerable coolness, from early in the morning, till about ten a clock, when it grows nauseously hot. But in the fields, they do this as well by letting their water hang all night in calabashes upon the trees; especially where the wind comes at them.

" We made three degrees of cold, viz. within doors, in the woods, and in the open air upon the ice. The latter was sometimes intolerable; no cloaths were proof against it; no motion could resist it: twou'd freeze the hair on our eye-lids, and thereby deprive us of sight; and wou'd, I am persuaded, have stifled a man in a very few hours time. Our faces, or other naked part, would be daily frozen in the woods; tho' here the cold was less mortifying than on the ice. Two thirds of our house were cover'd, on the outside, with snow, and the inside hung with isicles. Our bed-cloaths would be cover'd with an hoar-frost, tho' they stood near the fire. The cook's tubs, which were within a yard of the fire, and all day long supplied with melted snow, wou'd, while he slept but a single watch, be strongly frozen to the very bottoms; he was therefore obliged to water his meat in a brass kettle, placed close by the fire, where I have often found the side of the vessel opposite thereto very warm, whilst the other was frozen an inch deep. The surgeon's syrups, &c. notwithstanding his utmost care to preserve them, were all frozen; and our vinegar, oil, and sack, that stood in the house, shared the same fate. Both the sea and ground continued froze till June." Captain James.

A gentleman, who ascended the highest of the *Pyreneans*, call'd *Pic de Midi*, about the beginning of *September*, when the north side thereof was cover'd with snow, told me, that both he and his companions found the air very temperate on that part of the top where the sun did not come; but where that had free access, 'twas exceeding hot, and became offensive thro' a tent of oil'd-cloth, which they pitch'd there. Sometimes, also, they felt a cool wind on the top, but a much colder at the bottom. This hill may be seen from *Montauban*, that is, 27 leagues.

A physician assured me, that at *Morocco* he found some rosin of jalap, which he carried thither from *England*, melted by the heat of the air; and that it continued impulverable whilst he remain'd in that country; but that upon returning to *Tangier*, it became pulverable again.

From the *Relazione della Provincia di Malavar*. " Summer and Winter seem to meet in cape *Comorino*. Towards night, at any distance from the

"the cape either way, the weather and seasons are found very different, and even contrary: so that a person sailing on this side from *October* to *April*, has summer; and cannot in all that time double the cape, by reason he there meets the winter. This the good father who officiates in the churches of the cape finds by experience; and yet the distance between 'em is not above 2 or 3 miles."

An eminent virtuoso, who, at *Tirol*, descended into a mine 1800 feet deep, declared to me, that he did not find he passed thro' one hot region all the way; that at the bottom he breathed very freely, by means of the air-shafts; and that the air there was very temperate as to heat and cold, tho' it was now the summer season. Another person well versed in mines, acquainted me, that the deepest he had been in, was a tin one of about 400 feet; which in the summer season he found very cold at the bottom, and the greatest part of the way down, without passing thro' any hot region; that the cold became perceptible within two fathom of the pit's mouth as he descended; and that both in this and many other mines, he had found a sensible coldness, before he was got a yard below that solid earth, whereto the roots of vegetables seldom reach.

From a particular relation of several merchants, who together ascended the pike of *Teneriff*, we learn, that in their second days journey, when they were ascended about a mile, they found it excessive hot; till they arrived at the foot of the pike, where it was wonderfully cold, tho' in the month of *August*; especially after sun-set, when it began to blow violently. In their passage from hence to the top they found no considerable alteration in the air, and very little wind; but being arrived there, the wind was very impetuous. Mr. *Sydenham* told me, that ascending the pike of *Teneriff* on the south side, he found no snow, tho' on the north side there was much; that on the upper part he felt no wind; and that it was violently cold at the top.

To what depth will the ground and water freeze in hard winters?

Is the ice of *Muscovy* considerably harder than that of *England*?

Will water spirted into the air, freeze before it falls to the ground?

Will brandy, sack, &c. freeze in *Russia*? Or are the instruments made of iron and steel, much more brittle there than here?

How stands it as to the cracking of the timber in wooden houses? And what are the causes thereof?

How may flesh, fish, herbs, eggs, &c. be preserved in hard weather?

How are those to be cured, who have any part of their body frozen?

What are the symptoms of being froze to death?

A learned traveller assured me, that from an elevated place on the coast of *Genoa*, he had frequently, both morning and evening, discern'd the island *Corfica*; but cou'd never gain sight thereof when the sun was near the meridian, let the air be ever so clear.

The air considered with regard to light.

NAT. HIST.

King *Charles II.* did me the honour to acquaint me, that he once, from the beach near *Dover*, discover'd a new and uneven coast, in the edge of the horizon, on the other side the sea; whereat his majesty, as well as the duke of *York*, and the courtiers present, were surpriz'd; but having gazed a while thereon, it gradually disappear'd, as if it had sunk into the ocean, whence it seem'd to have sprung. This phenomenon I accounted for to his majesty, from subterraneous steams in the air, interposing between the coast of *France* and *Dover*, and causing an extraordinary refraction in the air; by means whereof the *French* coast was elevated to the eye, and so continued while that refraction lasted; but when the vapours were either raised too high, dissipated by the sun, or dispersed by the winds, the refraction ceased, and the object became invisible. This hypothesis I illustrated by the familiar experiment of a guinea and a basin of water; for that, or any other proper object, placed in the bottom of an empty basin, and render'd invisible by the interposition of the edge of the vessel, between that and the eye; if water be poured into the vessel, the guinea will then be raised to sight, tho' the eye remain unmov'd. The duke of *York* was also pleased to say, that being near the borders of *Scotland* one morning, in dull weather, and seeing the sky very red, he foretold a rainy day; but some of the *Scotch* nobility hence observed to his highness, that such a phenomenon in that country promised a fair one; and the event confirm'd it. And this observation, as I am inform'd by a nobleman of *Scotland*, commonly holds true, under due limitation; for that tho' when the redness appears near the ground, with narrow streaks of that colour in an intense degree, it signifies bad weather; yet if the morning blush be elevated in the sky, and the wind sit easterly, the day proves, generally, fair.

" I made some observations upon the rising and setting of the sun, " by means of very exact running glasses; for our clock and watch " were both so frozen, tho' constantly kept wrapt up in cloaths, and " placed in a chest, by the fire-side, that they wou'd not move. I " compared my observations made by these glasses, with the stars " coming to the meridian; and thus found the sun rose 20 minutes " too soon, and set as much too late; which proceeded from the re- " fraction of the air.

" One evening in *March*, the moon rose, in a very long oval, along " the horizon. The weather continued extreme to the 15<sup>th</sup> of *April*, " when our spring was frozen harder than it had been before in that " year. When the sun shone with the greatest purity of air imagin- " able, we cou'd not gain sight of a small island four leagues distant " from us; but when the weather proved misty, 'twas frequently " visible, even from the lowest ground. I took its height instrumen- " tally from the sea-side, and found it 34 minutes, when the sun was " elevated 28 degrees. This shews how great a refraction here is; " by means whereof I have found the land raised to the sight, tho' " the



" the sun had risen perfectly round. *January 6.* I observed the latitude exactly, when the weather was very clear, and found it  $51^{\circ}, 52^{\circ}$ .  
 " This difference proceeded from a great refraction. *Jan. 21.* The sun  
 " rose in an oval figure along the horizon. Others saw it besides my  
 " self, and we all agreed 'twas twice as long as broad; but as it gradually mounted higher, we found it recover its roundness. *Capt. James.*  
 " In *Poland*, near *Warsaw*, at the beginning of *June 1670*, we had very  
 " clear, but extremely cold weather; and for two days together observed  
 " the sun and two *Parhelia*, from about ten to twelve a clock; the air  
 " being perfectly serene, and icy spangles visible therein, like atoms in a  
 " sun beam. And as in common frosty weather, any smooth metalline  
 " instruments, brought from the open air into a warm room, will  
 " exhibit first a dulness, and then drops of water; so at this time  
 " there would immediately appear thereon something resembling an  
 " hoar-frost. Returning from *Warsaw* in the same month, I saw in a  
 " clear horizon, the sun rise with a large pillar over it, coloured like  
 " the rain-bow; and I remember *M. Hevelius* told me, he once observed  
 " it to set in the same manner."\*

A chymist, who passed the *Alps* with a gentleman of my acquaintance, informed me, that being there at the top of a forked mountain, they observed the valley between it almost cover'd with a thick thunder cloud, whilst the weather on both the tops continued fair; and in that cloud the lightning, which seem'd to lie deep, and shone quite thro' it, like a shining fish moving swiftly backwards and forwards in muddy water. I my self, indeed, remember, that passing the *Alps*, at a lower part than that just mention'd, tho' the weather was fair, and the sky at the top of our mountain clear, yet we saw dark clouds far below us, thro' part whereof we afterwards descended; when they seem'd to differ little from a thick fog; and after we had passed them, we found the weather fair at the bottom.

A curious nobleman, who had long resided at *Naples*, assured me, that after many fruitless attempts to see the famous apparitions in the *Sicilian* freight, he at length, early in the morning, thought he perceived two steeples in a neighbouring town, where he knew there was but one. And taking the opportunity of the next fair morning to renew his prospect; he was surprized to find a new town beyond that, where he before had seen two steeples, immensely greater than the known one; and furnish'd with walls, towers, churches, &c. This was also beheld, with surprize, by a physician who was with him. The colours, however, were, he said, nothing near so lively as the figures; being chiefly dim, and intermix'd with red. Nor did the spectacle

\* *Mr. Lowthorp* first contrived an apparatus sensibly to demonstrate the refraction of the air; which till then had only been perceiv'd by the nice divisions of astronomical instruments. See *Philos. Transf.* N<sup>o</sup>. 257.

And *Mr. Hawksbee* afterwards, by the direction of *Dr. Halley*, made an instrument to determine this matter with more certainty. See *Hawksb. Experim.* p. 225—230.

NAT. HIST. continue long ; for when the sun's rays became more direct and strong, they soon confounded this airy phantom, or mock-city.

“ Moist vapours are not the only cause or sign of the air's opacity ;  
 “ for that dry blighting east-wind, call'd by the husbandmen a red  
 “ wind, renders it at a distance thick and bluish. This is the wind  
 “ which for the two last years has proved so pernicious to all sorts of  
 “ trees, as not only to blast the fruit, but the very leaves thereof in  
 “ the tender.” That the air is sometimes clear and transparent, and  
 at others darken'd and clogg'd by terrestrial steams, need not be  
 said ; but there are other phenomena of that fluid, depending upon  
 its density, transparency, &c. which pass unobserved by the vulgar,  
 and require skill in the doctrine of refraction to understand ; on  
 which, therefore, I shall not now insist. There are also others no less  
 worthy of our notice. By comparing the different accounts of eminent  
 authors, as to the number of the fixt stars, with some observations of  
 my own ; I was induced to suspect the several constitutions of the  
 air might occasion some variations herein. And, upon enquiry, I  
 learnt, that celestial observations are most successfully made, where  
 the air is purest ; but particularly, I suspected, that intense cold, by  
 precipitating the vapours of the air, wou'd render it fit for this pur-  
 pose. To confirm this conjecture, an ingenious physician told me,  
 that travelling one night in *Russia*, whilst the weather was excessive  
 cold, both he and his fellow-travellers stopp'd, to contemplate the  
 unusual brightness, and immense number of the stars, beyond what  
 they had ever till then beheld.

“ *Charlton Island, January 30 and 31.* In the beginning of the night,  
 “ there appear'd more stars by two thirds than ever I saw before.  
 “ The cloud in cancer was full of small stars ; and a great many ap-  
 “ pear'd among the *Pleiades*. About ten a clock the moon rose, when  
 “ a quarter of them became invisible. The wind, for the greatest  
 “ part of this month, has stood northerly, and blown very cold.”  
 Captain James.

The *Russian* emperor's physician assured me, that one night, when  
 'twas prodigiously cold and clear, he observed more stars than ever  
 he had seen in *England*, or the neighbouring parts of *Europe* ; particu-  
 larly several about the *Pleiades*, and abundance of new ones in other  
 parts of the sky ; and that they appear'd by far more bright and  
 beautiful than usual. Those who travell'd with him, he said, also  
 made the same observation.

“ On the 29<sup>th</sup> of *November*, past, II at night, I saw a light in the  
 “ north-east, along the horizon, like the day break ; when looking due  
 “ north, I beheld several streaks of light, resembling the tail of a  
 “ blazing star, that all pointed north and south ; one whereof was  
 “ longer than what we saw the last year, for it reach'd from the  
 “ horizon to the zenith ; passing between *Charles's* wain, and the north  
 “ star. The small ones sometimes disappear'd, and others of the  
 “ same

" same magnitude appeared in their places, but all near the great one ; NAT.HIST.  
 " two of them seemed to come from the two guards in *Charles's*  
 " wain, and when these vanished, others arose more to the south.  
 " This light extended from W. N. W. to E. N. E. About the  
 " time of the last new moon such another phenomenon was seen by  
 " the lord *Belearus*, as he came, by night, from *St. Andrews* ; by the  
 " sailors of the yacht at *Leith*, and by some persons in this town. And  
 " tho' the sky was not then clear, yet it gave a light sufficient to  
 " read by. It began, they told me, about seven, and continued till  
 " nine. These phenomena are surprizing to us who are strangers here,  
 " but the natives say, they frequently happen." \* This account came  
 from his royal highness the duke of *York*, then high commissioner in  
*Scotland*.

The generality of men are so accustomed to judge of things by their  
 senses, that because the air is invisible, they ascribe, but little to it, and  
 think it but one remove from nothing. And this fluid is even by the  
 school-men, consider'd only as a receptacle of visible bodies, without ex-  
 erting any action upon them, unless by its manifest qualities, heat and  
 moisture ; tho' for my part, I allow it other faculties, and among  
 them, such as are generative, maturative, and corruptive ; and that  
 too in respect not only of animals and bodies of a light texture, but  
 even of salts and minerals. An intelligent person, who had often sail-  
 ed from *Europe* to the *East-indies*, told me, they included their thick  
*Cheshire* cheeses in proper leaden boxes, and by that means preserv'd  
 them sound, during the whole voyage ; but that when such a method  
 was not made use of, upon cutting one near the equinoctial, the  
 greatest part of it would be very dry, brittle, and seem spoiled, while  
 the central parts remain'd fat and soft ; as if the moisture of the whole  
 cheese had retir'd thither : for if the same thing were done when  
 they were come from the torrid into the temperate zone, the exter-  
 nal portion would be good, and the cheese return to an uniform con-  
 sistence.

*The effects of  
 the air on se-  
 veral bodies.*

" *Query.* Are not the moist particles, which float in the air, the  
 " cause of all corruption in bodies ; since according to *Acosta*, every  
 " thing in *Peru*, (and the same is observed of *Egypt*) where it seldom  
 " rains, continues long uncorrupted ? or is this resistance of putrefaction  
 " rather owing to the nitrous salt wherewith the air of those countries  
 " abounds ? "

A man of learning, who had often crossed the line, in *Portuguese* ships,  
 told me, that upon their near approach thereto ; he observed a great

\* The like phenomena have of late been  
 frequently observed in several other parts  
 of *Europe* ; and particular accounts are gi-  
 ven of them in the *Philosophical Transactions*  
 and the *French Memoirs*. Mr. *Whiston* also  
 published a small treatise upon that re-

markable *Aurora Borealis*, which appeared  
*March 6. 1715-6*. But the physical cause  
 of these lights has hitherto been only  
 guessed at. See *Philos. Transact.* N<sup>o</sup>. 310,  
 347, 376, &c.

change



NAT. HIST.

change in the consistence of their basket, and that most of their provision, and even their salt-fish, was so damaged thereby, as to be scarce edible. He added, that their pilot, who had been above twenty several times in the *Indies*, assured him, their fresh water was never thick or fetid under the equinoctial; but always as if newly put into the cask.

Dr. *Stubbs* assured me, that the silks brought to *Jamaica*, will, if there exposed to the air, rot even whilst they preserve their colour; but if kept therefrom, hold both their strength and die.

An experi-  
ment.

Upon opening a small glass receiver, wherein half a lemon and a mercurial gage had been included for above three years, we found the fruit had preserved both its form and colour; the upper part of the pulp was, indeed, depressed, and seemed to be dried, but the juice there wanting, appeared upon the glass-plate, whereto the receiver was ground and fitted; which being separated, a large quantity of external air rush'd impetuously into the receiver. Neither the lemon, nor its lost juice, had acquired any ill scent, or the least signs of putrefaction or mouldiness; whence I conjecture, as mould appears thro' a microscope, to be a vegetable, it requires the assistance of the air to its production. The juice was clear and without feces, in colour between brown and reddish; its taste was acid, and it turned the syrup of violets purplish, and immediately corroded small pieces of coral without the assistance of heat.

A scholar told me, that as he several times sailed near the line, he found some lozenges, which he usually carried in his pocket, quite dissolved; tho' they never lost their consistence in any other part, nor continued fluid when he was got a few degrees beyond the equator.

A gentleman of *Sweden*, who dealt in the metals of that country, inform'd me, 'twas the practice, in the principal copper mines they had, to make use not of iron chains, as in other mines, to draw up their oar with, but to fasten their baskets to ropes, prepared of ox-hides; because the links of iron, they found, were very subject to break, when loaded in hard winter weather. The master of a glass-house informed me, that well Neal'd glass-metal would, sometimes, break of it self, with violence, long after 'twas made; and that, in particular, having, once set by a large parcel of glasses, for half a year, he found, at the end of that time, a fourth part of them spontaneously broken; the cracks generally proceeding from some of the salt not sufficiently comminuted, which appeared like small stones therein. And a learned gentleman, the owner of an iron mine, informed me, that at his house in *Suffolk*, which stands within six miles of the sea, and has been built but 80 years, the iron bars of the windows, looking southward to the salt-water, are so swelled, rotten, and brittle, as to be easily pulverable. He farther said, that several iron bars of his, lying near the sea-shore, were accidentally drench'd, for some hours, in the salt-water; whence they

they easily yielded thick flakes of rust when they came to be hammered. NAT.HIST.

An experienc'd mason told me, that *Salisbury* cathedral is built of *Purbeck* stone, which gradually becomes softer, and moulders away in the air; that the same is observed of some *Blechnington* stone, tho' kept from the wet; but that what comes from *Painswick*, within four miles of *Glocester*, tho' soft and friable at the first, will, by lying in the air, acquire an hard, yellowish, glassy crust, like marble; which grows the faster for being often wash'd, but reaches very little below the external surface.

I am informed, that candles will, sometimes, continue burning in grooves, unfurnished with air-shafts, at the depth of ten fathom; but that when they come into close ground, the dust, raised by the workmen, (especially if the stone be full of mundic) will extinguish them, unless fresh air be convey'd into the pit. *Air considered with regard to flame.*

To burn candles, spirit of wine, match, touch-wood, spunk, &c. under a glass bell; and to keep animals therein, whilst the flame continues. To burn bodies to ashes, in sealed glasses. To do the same in close receivers. To burn cotton in a sealed glass. To make a mixture of flames, under water, in an exhausted receiver. To burn spirit of wine, and oil of tuppentine, in glass vessels with slender necks. To make experiments by burning of gun-powder; and by trying to fire a pistol in an exhausted receiver. To burn saline substances in an exhausted receiver. To burn mixtures made with salt-peter in exhausted receivers. \* *Experiments to be made.*

Having put a small handful of raisins into a bolt-head, half fill'd with water, we exhausted the air therefrom, and placed the containing receiver in a digesting furnace, to forward the fermentation; the season being then cold. After a while the raisins emerged and floated, for some days, on the top of the water, when most of them appeared surrounded with numerous bubbles, and but very few of them subsided; tho' the number of bubbles afterwards decreased daily, and a sediment appeared at the bottom of the glass. In a fortnight after this experiment was began, the upper part of the glass being accidentally broke, while I stood by it, the external air rush'd violently thereinto; and I perceived the surface of the liquor overspread with bubbles, resembling the froth of bottled beer. There also seemed to issue from the broken apex, a visible fume of a languid scent. The liquor was highly tinged with the raisins, and seemed to have gained a thicker consistence than that of water. *An experiment to shew the effect of air in fermentation.*

\* It appears from some experiments made by Mr. *Hauksbee*, that the air passed thro' red hot metals or charcoal, and respired by animals, is sudden death; and that it instantly extinguishes the flame of a candle; tho' the air, by this management, loses nothing of its spring or specific gravity; but if passed thro' a red hot glass-tube, or metals, with no greater heat than that of boiling water, it seems to have no such pernicious effect. *Hauksbee's Experim. p. 282—288.*

Up-

**NAT. HIST.** Upon opening an exhausted receiver, wherein a large quantity of verjuice with green, four grapes, had lain included for three years, there appeared no mouldiness any where; only the surfaces of the uppermost skins were a little discoloured with something, which by its taste, and appearance, thro' a microscope, I suspected to be a kind of tartar. The liquor they had afforded was acid upon the tongue, and would dissolve coral without heat; but the skins had a musty scent. The mercurial gage shut up along with the verjuice, shew'd scarce any air to have been produced therein, during all this time.

*The operation  
of the air on  
the odours and  
tastes of bodies.  
Experiment 1.*

The lord *Sandwich*, and two gentlemen of his retinue, assured me, that the common report as to their having no necessary houses at *Madrid* was true; and that tho' they always make a jakes of their streets over night, 'tis not easily discoverable by the scent the next morning. *Madrid*, however, his lordship said, had a more offensive scent than any city he knew; but they all three agreed, that the place wherein the ambassador's family constantly made water, had no scent of urine, and that they frequently observed both the dogs and cats, which lay dead in the streets, afforded no offensive smell.

**Experiment 2.** Upon opening another exhausted receiver, wherein, for above three years, some large pieces of oranges had been included, we found their rind changed almost black, scarce any liquor afforded, no putrid scent, nor the least mouldiness upon any of them.

I learnt from Mr. *Nickson*, that they preserved beef without salting it, during all the time the frost lasted, that is, the whole winter; but that when once thoroughly frozen, 'twou'd never, tho' well dress'd, have its natural relish.

*Upon their  
colours and  
texture.*

A learned man acquainted me, that he found the air of *Brasil* had a great influence upon the colours of cloaths, and even upon black; so that the sable taffaty, which is there worn by the higher rank, will, in a few days, become of an iron colour; tho' when kept close in the shops, it preserves its proper hue. He also informed me, that at a place 50 leagues beyond *Parigna*, white people soon grow tawny; and as soon recover their native colour, by removing out of that quarter. The same gentleman further said, that upon *Charlton Island*, there are birds resembling our wild pigeons, but called by the *English* partridges; which appear white in winter, and grey in summer. The physician to the governor of *Jamaica* told me, that *Lignum vita*, and most other trees in that country, when fresh cut down, wou'd soon grow green on the new made surface, if that were exposed to the air, while the parts immediately below it remain yellow; and that *Guaia-cum* is soft whilst growing, but when fell'd acquires such a hardness in the air, that an ordinary tool will not touch it. Several other trees, he said, had there the same property; but particularly the cabbage tree; the pith whereof will soon rot of it self, and leave a large, hollow pipe, perhaps an hundred feet in length; which, instead of corrupting, grows almost as hard as iron, in the ground. A curious



rious traveller informed me, that having gathered some of the aloes NAT. HIST.  
 plant, which grows plentifully in the island of St. Jago, the juice where-  
 of is not only exceeding glutinous and bitter, but of a very dark  
 colour, and carried it towards the equinoctial, he there found the  
 juice lost its bitterness for a season, and became green.

Stains caused by vegetable juices, are best taken out of linen at that  
 time, when the several plants which afford them are in their prime.  
 This one lady has experienced in new linen stain'd by the juice of  
 quinces; and another in some discolour'd by the juice of hopps,  
 which she thinks makes the worst of stains; but having long tried in  
 vain to fetch this out, she lock'd up the linen in a chest till the season  
 of hopps came on, when the spots thereof vanished of themselves.

Having mixed one part of *Lapis Calaminaris* in powder, with four Experiment 1.  
 parts of fine salt-peter, we kept them for some hours in a strong cru-  
 cible and a vehement fire, till the stone was prepared; whereon we  
 afterwards poured a proper quantity of fair water, which afforded an  
 untransparent solution of a deep red colour. This we put up into a  
 wide mouth'd glass, and suffer'd it to stand in a south window expos'd  
 to the open air; where, in a short time, it became quite green, and  
 less turbid than before; and continuing here for some days longer,  
 its green colour vanish'd by degrees, and the liquor appear'd transpa-  
 rent; letting fall to the bottom a red powder like brickdust. The same  
 changes happen'd in more than one parcel of this solution.

Upon boiling strong spirit of vinegar for a while with crude filings Experiment 2.  
 of copper, 'twas not apparently coloured thereby; nor even after it  
 had stood for some hours in the glass egg wherein it was boil'd; we  
 therefore poured them both together into a broad flat glass, and set it  
 shelving in a window, that only one part of the filings might lie bu-  
 ried in the menstruum. So much of the metal as was thus immediately  
 expos'd to the air, became of a greenish blue; whilst that cover'd by  
 the liquor, held its own colour, till by gradually evaporating the men-  
 struum, it came to touch the open air, upon which it acquired the same  
 colour with the former.

We put one parcel of copper filings into a flat, shallow, wide-mouth'd Experiment 3.  
 glass, and another into a common vial; then pouring upon each a proper  
 quantity of sal-armoniac dissolved in fair water, we let the vessels  
 stand together, uncover'd, for a considerable time; at the end whereof  
 we found, as we expected, the liquor in the closer glass faintly tinged,  
 while that in the more open one, was very deeply coloured. 'Twas re-  
 markable here, that tho' the lower part of the solution appear'd of a  
 deep, ultramarine blue; the upper surface was cover'd with a film,  
 like thin ice, which in colour resembled a fine turquoise.

Two small parcels of copper filings being laid upon paper coffins, Experiment 4.  
 we added to each of them three drops of spirit of sal-armoniac; then  
 leaving one of them in a window, we placed the other in a receiver,  
 which was immediately afterwards exhausted by the air-pump. Two

**NAT. HIST.** minutes had not passed from the dropping on of the spirit, before a manifest blue appear'd on some parts of the paper left in the window; but that in the exhausted receiver continued colourless for a full quarter of an hour; when, taking off the glass, and removing this paper to the other, in about two minutes, it discovered a blueness, which, in two more, grew considerably deep.

**Experiment 5.** By dropping some copper filings into a slender vial, containing a proper quantity of the urinous spirit of wine lees, whose colour is yellow, and stopping up the glass, we gain'd a tincture manifestly green; then suffering the glass to stand for several days in a window, we found the liquor slowly return to a yellow, and at length to lose all its green colour; when, upon opening it to admit the air, and stopping it again, the surface of the liquor began immediately to change green; and this colour gradually spread downwards, till the whole was tinged: but by long standing, it gradually alter'd to a pale yellow. Having preserved several vials full of this liquor, I perceiv'd one of them, which had once lost its colour, regain'd a fair blue by standing, tho' the including glass remain'd constantly stopped; and tho' the liquor in the vial that stood next it, which was the same spirit impregnated with filings taken from the very same parcel, continued colourless. This glass, indeed, was only stopp'd with a cork, but I observed the same phenomenon in a bottle with a glass stopple: nay, I afterwards found it so in another, whilst in one stopp'd with a cork, that stood by it, no colour appear'd. These glasses were all fill'd with the same materials, and on the same day with those abovementioned; and at the time of this observation, made in *August*, the weather was colder than usual. Looking also, about this time, upon some spirit of amber, which had for several days stood upon copper filings, the glass being sometimes unstopped to admit the air, I found it had gained a green colour, tho' it before obstinately preserved its own.

**Experiment 6.** A slender vial filled with spirit of honey, tho' subject immediately to exchange its yellow colour for a blue, by receiving the air upon its surface; yet being once open'd in the place where it used to exhibit this phenomenon, it remain'd of a transparent yellow, for an hour before it turn'd blue.

**Experiment 7.** I have observed a certain liquor frequently lost and regain'd its colour, appearing sometimes of a faint, sometimes of a deep blue, and sometimes colourless; whilst the fluid in another vial that stood near the former, wou'd sometimes correspond therewith, and at others vary from it. The weather seem'd not to be the cause of this variation, for the liquors wou'd both acquire and lose colour indifferently on cold days or hot.

**Observations.** A gentleman of my acquaintance told me, that in a large piece of ground in *Wales*, near a mountain famed for the thing, he saw abundance of hard stones like flints, some of a dark colour, and others grey, which when newly turn'd up in tilling, appear'd of a rust colour, but afterwards grew

grew gradually whiter; so that in three years time he found almost the whole parcel turn'd white. He added, what the inhabitants of the place assured him, that almost all the stones which lay in the neighbouring mountain exposed to the air, underwent the same kind of changes, and were, in a few years, blanch'd.

"Some *Mercurius dulcis* and roman vitriol lying together in the same box, but wrapp'd up in different papers, for the space of two and twenty months, the former was thereby changed to a substance so like antimony, that it was mistaken for it even by persons skill'd in drugs; the vitriol also had acquired the same colour on its surface, but it sunk no deeper."

Upon the filings of copper put into a crystal glass of a conical figure, we poured some strong spirit of salt to the height of a finger's breadth above them; when exactly closing the vessel with a glass stopple, we let it continue unmoved in a window for some days, till the liquor had obtain'd a high, darkish brown colour, lost it again, and grew clear like common water. Then taking out the stopple, without shaking the liquor, and giving access to the air, the surface of the liquor, in a few minutes, regain'd a darkish brown colour; which gradually descending deeper, the whole body of the liquor appear'd tinged with it in a quarter of an hour. The glass being again well stopp'd, the menstruum in a few days lost its tincture; which, when the stopple was taken out, it recovered as before. And thus it succeeded upon some other trials also: but afterwards keeping the glass for a month or two together in the same place, I did not find that the liquor grew clear any more. Experiment 8.

Having out of another conical glass, furnished with the same materials, taken out the stopple, after the liquor had for some time appeared clearer than usual, we left it open for about half an hour; but the menstruum acquired no colour, not even at the top. When putting the stopple in again, I left the glass closed for two or three hours, and afterwards found the liquor had acquired a faint colour, tending to green. Upon this I again admitted the external air, leaving the glass unstopp'd for above 20 hours; but in all that time it had not regain'd its usual dark colour; appearing only of a deep green, but neither true, nor very transparent. Experiment 9.

Some strong spirit of salt having been kept upon copper filings, till the solution appear'd of a dark brown colour, we put about 3 spoonful of it into a receiver, that wou'd contain ten times the quantity. This being kept *in vacuo* for about half a year, it retain'd its colour, but the vessel being open'd, and free access permitted to the air, the solution, in an hour's time, was turn'd into a fine transparent green; tho' there appeared no precipitation of any muddy substance. Experiment 10.

A convenient quantity of our spirit of salt being put upon copper filings in a conical glass, we observed that the deep, muddy colour long continued; till towards the end of *December* the liquor appeared like Experiment 11.



NAT. HIST. common water : when admitting the external air, its operation was scarce sensible for some time ; but within 24 hours the menstruum had acquired a faint, and moderately transparent green. So that this tinged liquor, as it very slowly lost, so it slowly and imperfectly recover'd its colour.

Experiment 12. Upon filings of copper, in a vial that wou'd contain 2 or 3 ounces of water, we poured strong spirit of sal-armoniac, made without quick-lime, to near an inch above them. This was done *August* the 20<sup>th</sup>, on *Friday* before noon ; and by the following *Monday* in the afternoon, it had acquired a deep blue tincture, and lost it again so far, that 'twas almost pale like common water. Then I unstopp'd the vial, and in a minute or less, the surface of the liquor acquired a deep blue colour, that reach'd considerably downwards ; the whole quantity becoming, in 4 or 5 minutes more, of the like colour : and the glass being presently stopp'd, and left in the same place, appeared not at the end of nine days to have lost its tincture ; tho' now and then, within that time, it seem'd manifestly paler than when we stopp'd up the vial.

Less obvious  
qualities in-  
troduced into  
bodies by the  
air.

A gentleman, who resided for a year in *Guinea*, found, as did others, also, of his company, the heat and moisture of the air so favourable to putrefaction, that their white sugar would, sometimes, be full of maggots ; that several drugs, plasters, &c. quite lost their virtue ; and that some of them, especially their unguents, were verminous. He said farther, that in the island of *St. Jago*, they were obliged to expose their sweetmeats to the heat of the sun ; and thereby exhale the moisture they contracted in the night, which would otherwise cause them to putrefy.

" *Oxford*, tho' seated chiefly on a gravelly hill, has been found very disagreeable to some hypochondriacal and valetudinary persons, especially in the spring ; I, therefore, suppose the air of that place to be generally moist."

Air too dry, tho' sufficiently hot, is unfavourable to the production of several insects. I have observed in these two last dry springs, that no soft garden snails were to be found ; and that very few fleas infested the houses, for want of moist vapours to nourish them ; but in wet summers, snails, fleas, gnats, &c. appear in abundance.

" *Antimonium diaphoreticum*, whether prepared with nitre alone, or an addition of tartar, will, in time, if it be exposed to the air, gain a noxious quality ; and upon being taken, occasion fainting, vomiting, &c. but this effect is easily prevented by exhibiting the medicine fresh prepared ; or when kept too long, by committing it alone to the fire for an hour or two, or if fresh nitre be added, by edulcorating, and a little reverberating the preparation." *Zwelfer*.

A physician of the college at *London* assured me, from his own observation, that *Antimonium diaphoreticum*, having been kept for some years, tho' in a close vessel, acquired an emetic quality. Ceruse of antimony, tho' it stood in a stopped glass, he also found did the same ;

fifteen grains whereof he had given for a dose, without the least inconvenience, when the preparation was fresh: but after it was stale, four or five grains of it would vomit. NAT.HIST.

"If some *Egyptian* earth be taken up near the river, and carefully preserved from wet and waft, 'twill be found, if duly examined by the balance, neither to increase nor diminish its weight till the 17<sup>th</sup> of June; when it will begin to grow heavier, and continues to do so as the river fills; whence they certainly know the state of the deluge, which, doubtless, proceeds from the moisture of the air." Prosper *Alpinus*, *Joh. Varot*, &c.

Earth, thrown on a heap, and suffered to lye for five or six years in the air, makes better pots for closeness and bearing the fire, than what has only lain one season above ground; tho' this be preferable to that which is newly dug; as being not so apt to crack in the fire, or by wet. Such bricks, also, as lye near the top of the kiln, in burning, are apt to fail, when they come to be exposed to the weather.

'Tis a common observation, the difference there is between the two sides of the *Pyreneans*, that which looks to *France*, and that which reaches to *Spain*; the former being verdant and flourishing, whilst the other is scorch'd and barren. This seems owing to the parching winds, which are, sometimes, blasting, and beat upon the *Spanish* side of the mountains; whereby the other is skreen'd, and enjoys all the advantages of the soil and climate.

*Air, as it regards vegetation, generation, life and death.*

"As to life and death, with the considerations thereto belonging, we have already spoke to them; in like manner, also, not only physicians, but philosophers, have a right to discourse of the causes of health and diseases; for as those physicians, who have any tincture of accuracy and elegance, derive the principles of their art from nature, so all accurate philosophers trace nature up to physics." *Aristot.*

The temper of the air may, universally, be derived from the subterraneous vapours and superficial effluvia of the earth, variously transposed, blended, and compounded by the winds, and other motions; and, probably, upon the different mixtures hereof all the local qualities of that fluid depend. A physician acquainted me, that about three months before the last great plague in *London*, he was consulted by a man, who complain'd of a swelling in his groin, and thereupon confidently asserted, that the plague would rage dreadfully, during the following summer, in the same city: his reason was, that having once had a pestilential tumour, in a former great plague-season, two other less violent plagues were, severally, preceeded by a less degree of the same symptom in himself.

The bare local motion of the air may, in particular cases, operate upon bodies, either by being changed into wind, modified into sound, or disorder'd by thunder. 'Tis evident, that according to the vehemence

**NAT. HIST.** mence or slackness of the wind, and the places from whence, and to what quarter it happens to blow, various effects ensue, especially in animate bodies; and this not only as it is attended by cold and heat, moisture and dryness; but consider'd as an aerial stream, whereby it fans the places through which it passes, expels the stagnant air, and introduces fresh; hence it, doubtless, may contribute to many changes in the health of animals, but more especially in the tender sort of them. I was informed, in *Languedoc*, that if thunder happens there, after the silk-worms had eat their fill, and began to dispose themselves to spin, a great part of them would be destroy'd.

Upon letting horses down, a third of the way, into mines of a thousand feet deep, one told me, several of them died; but that others survived, and work'd the engines there, without any sensible inconvenience in respiration; tho' the places they moved in, were supplied with air, only by the groove through which they descended, and one moderate shaft.

A curious traveller, who had visited the mines of several countries, told me, that the deepest he had seen was in *Bohemia*, sunk about two thousand *English* feet.

The *English* consul at *Tripoli*, and some time governor of the coast-castle belonging to the *English African* company, informed me, that the air in those parts was not constantly hurtful, but frequently became so, when many of his men, who were before healthy, would suddenly fall sick together, especially of fevers and fluxes, which usually killed them in eight and forty hours time.

The *Russian* emperor's physician assured me, that once, when the frost was very great in their country, and the wind at north-east, if that blew against his face in walking, he was unable to breathe; so great a stiffness was thereby caused in the organs serving to that purpose; whence he was obliged to turn his head from the wind before he could respire.

An observing person informed me, that when the ship, he sailed in, came under the line, he perceived the lice left the bodies of the *English* that were on board, and got wholly into their heads; from whence they descended again, some time after they had passed the equator. Another acquaintance of mine, who frequently crossed the line in *Portuguese* ships, which usually go crowded with people to the *East-indies*, declared, that he carefully observed their swarms of lice died away upon passing the equinoctial; tho' that vermin grew troublesome again soon after.

The duke of *York* observed, during his stay in *Scotland*, that agues, at the same time they were very frequent here, scarce appeared in that country. A *Scotch* nobleman afterwards confirm'd the same, especially of quartan agues; adding, that 'twas once thought very strange when a certain gentleman happened there to fall sick of one; and that quar-



quartans, which are frequently brought from *England* to *Edinburgh*, are usually cured by any considerable stay in that city.

"The air is purify'd by destroying the cause of corruption therein; if it be too much moisture, fire is the remedy; especially when made of odoriferous plants, as laurel, myrtle, rosemary, &c. by which means *Hippocrates* prevented the plague at *Athens*. Noxious vapours may also be dispersed herein by the blowing of high winds. Thus the plague was lately stopp'd at *Lisbon*, by a great storm which lasted for three days together. The like also happen'd in *Morocco*, where the same distemper raging very severely, was dissipated by a wind that blew as hot as the steam of a furnace. Artificial storms may be rais'd by frequently unloading great guns; but if the vapours proceed from stagnant waters, they ought to be drain'd off the land thro' proper canals; or frequently renew'd, by bringing a river to pass thorough them. Thus the great duke of *Tuscany* has render'd the air of his city wholesome. If dead carcases, by lying unburied, have infected the air, deep pits should be dug to receive them; but if filth and excrements be the cause of the plague, as I believe it is at *Constantinople* and *Lisbon*, both the streets and houses must be well cleansed and purified." *Roderic. Fons.*

"'Tis remarkable, that tho' the plague rages almost every year, round a particular place in *Gork*, where large quantities of mercury are found; yet it never reaches that place itself. This has been constantly observed by very aged men, who also received the tradition from their ancestors." *Michael Majer.*

"Quicksilver is an alexipharmic in many distempers; and, 'tis said, even in the plague itself, (since those parts where 'tis found, remain almost constantly free from the contagion) provided no salts or corrosive fluids have infected that mineral, or given it a poisonous quality."

A very ingenious physician told me, he learnt upon the island *Ternate*, that the *Dutch* having agreed with the king, to sell almost all the clove trees that grew there, in order to raise the value of their spice, such a change in the temper of the air happened thereupon, as shew'd the exhalations of the blossoms, that, when dried, afford the cloves, to be very wholesome; for soon after these fragrant trees were cut down, the whole island became exceeding sickly; which my relator imputed to the corrosive and noxious steams of a vulcano there; the ill effects whereof were formerly prevented by the aromatic effluvia of those spicy blossoms. And so remarkably was the constitution of the air alter'd, at the time he was there, that as valetudinarians, before this happen'd, usually resorted thither from *Batavia*, the *Dutch* had now, for several years, been obliged to send men, from that and other more healthy places, once in six months, to relieve their garrisons here, and carry back the sick, which were generally very numerous. A physician lately return'd from *Tangier*, told me, that tho' the place itself be healthy, yet

NAT. HIST. yet strangers, upon their first arrival, were usually feverish, for many weeks; especially if a sharp continued wind blew from the east.

An Experiment.

Including a few small ants in a receiver, we found them very brisk and lively; but, upon drawing away the air from them, they presently lost their motion; but soon recover'd it upon re-admitting the air: when exhausting the receiver again, the insects lay, some upon their backs as dead; and thus we suffer'd them to remain for five or six hours; then letting the air into them, they continued in the same state for above twenty minutes; but at length recovering, they ran nimbly about the glass, tho' it was now late in the night.

The manner of fishing for mother of pearl; from the *Relazione della provincia di Malavar*. "The barks intended for the fishery being equipp'd, repair to the island of *Ceylon*, along the coasts whereof, for twenty miles in length, at the distance of two or three from land, and the depth of 6, 8, or 10 fathom, are found immense quantities of mother of pearl. The barks setting out in the morning with a land wind, cast anchor at their arrival; and the divers, whereof each bark carries fifteen or twenty, begin to dispose themselves for the work. In order to this, each ties a rope about his middle, one end whereof is held by a person left in the bark; and with another rope he ties a stone to his leg; care whereof is likewise taken by a person in the bark. Lastly, he girds a leathern budget before him, and putting gloves on his hands, he precipitates himself into the sea; the others all the time giving him rope enough. Thus, by the weight of the stone, he is sunk readily to the bottom; where untying the stone, he is at his liberty, and the stone is drawn up again. The diver now begins with great care to rake up the mother of pearl he meets withal, putting them up in his bag; and whenever he perceives himself begin to want breath, pulls the rope that girds his middle, upon which he is instantly drawn out; when, discharging himself of his fish, he ties the stone again to his leg, and dives again as before. The work is very toilsome, and even dangerous; the great depth of sea at which the mother of pearl is found, frequently occasioning them to be suffocated."

'Tis a constant observation, that if any foreigners lie all night on shoar at *Johanna*, they seldom escape being sick there, or soon after they depart; the distemper usually proving putrid and mortal in two or three days; whilst those who remain all day long on the shore, provided they every night lie on board their ship, distant above a mile from the land, commonly remain healthy. This island abounds with the greatest variety of vegetables imaginable; and 'tis here excessive hot in the day time, but cold after sun-set: whence, possibly, many volatile parts of those plants are gradually raised by day, and suddenly condensed by night; and at that time taint the mass of blood, being inspired with the air. The inhabitants themselves are very subject to fevers, for which they scarify their breast and abdomen in several places; tho' few recover, unless

unless they break out in blotches on several parts of the body. There stands a hill here of a remarkable height; the top whereof is almost constantly cover'd with thick fogs or clouds, which rise higher, or sink down lower, as the weather alters.

Upon the coast of *Coromandell*, and the most maritime parts of the *East-Indies*, there are, notwithstanding the heat of the climate, annual fogs so thick, as to occasion those of other nations, which reside there, and the more tender part of the natives, to keep their houses close shut up. And at *Balassore*, in the bay of *Bengale*, and several other parts of that country, so great a corruption of the air is occasion'd by the rains which fall there, that the scent of it is very offensive to the inhabitants. This, I presume, chiefly happens from the great number of frogs, and other reptiles that are there left after an inundation, to dry and putrefy by the violent heat of the sun. At these times also a violent sickness, being chiefly feverish, proves very fatal to the natives.

When the *English* ships return from the *East-Indies*, they usually carry their sick on shore at *St. Helens*, where they commonly recover in a few days; which in all probability is owing to a change of the air, not diet; for the same provisions may be had by the diseased in the ships.

"The shortest passage from *Mosul* to *Bagdad*, is thro' *Mesopotamia*; but there lies no village in the road; and, besides, the wind *Samiel* blows all summer long, from *Mosul* to *Surat*; for which reason travellers are obliged to go by water on the *Tigre*. The word *Samiel*, signifies a poisonous wind; which, perhaps, is the burning wind mentioned by *Job*. Whoever breathes herein dies upon the spot; tho' some have first been heard to say they burnt internally. The body, soon after it's dead, becomes black all over, and the flesh easily separable from the bones." *Thevenot*.

*Doctor Collins* relates, that in *Muscovy* the horses are very subject to a particular distemper; from which the natives usually preserve them by keeping goats in their stables; and this method the doctor himself was obliged to take with his own horses.

The *English* consul at *Smyrna* informed me, that the plague there, tho' it abates not so considerably as at *Aleppo*, towards the beginning of *July*, when the weather is excessive hot, yet becomes less mortal and infectious at that time; the cause of which phenomenon may, perhaps, be, that the pestilential effluvia floating in the air, during the former part of the summer, must be of a particular magnitude, to exert their full force; so that the weather growing vehemently hot, those particles are thereby dissipated, lessen'd in their bulk, and render'd less noxious. Thus the wick of a candle just extinguish'd, proves very offensive to the nostrils, while the parts of the smoke it emits are gross; but if that smoke be lighted, or rarified into flame, it sends out particles of a quite different nature, and of an inoffensive scent. It may be further said, that the heat of the sun, at times, acting powerfully, penetrates deeper into the earth, and agitates the lower parts thereof; opening its obstruct-



NAT. HIST.

ed passages, and raising into the air various corpuscles, to attenuate and divide the pestilential ones; or else, by mixing therewith, form new concretions of a different bulk, texture, figure, or motion; and thus render the diseases they produce less malignant, or of a different nature from the former. If the plague suffers this alteration only at *Smyrna* and *Aleppo*, it may be owing to the disposition of the soil in those places to emit pestilential particles of a determined nature, by a particular degree of heat, and dissipable by a greater, and thence to afford peculiar exhalations able to correct the former; as 'tis annually observed at *Grand Cairo*, that the plague, during the heat of summer, ceases to be mortal, and grows much less contagious, when the *Nile* begins to overflow. This seems occasion'd by nitrous, or other exhalations, plentifully afforded from the arrival of fresh water; and not from the coolness it occasions; since the plague will rage in much colder weather than can happen in *Egypt* during the month of *July*.

The air being fluid, as well as water, and impregnated with salts of different kinds, 'tis not improbable, that what happens in water, impregnated with such salts, may also happen in the air. Two proper quantities of different salts being dissolved in hot water, they floated undistinguishably therein, and retain'd a capacity to act in conjunction upon several occasions; yet when the liquor became cold, the saline particles of one kind being no longer agitated by a due degree of heat, shot into crystals; and losing their fluidity and motion, visibly separated themselves from the other, which still continued fluid in the liquor, and capable only of acting separately. Hence it seems probable, that coldness and heat may, for a time, greatly alter the qualities of the air, with regard to the bodies and health of mankind. The clearest instance I have seen of this observation, was afforded me by the following experiment.

Experiments.

Having dissolved equal quantities of alum and nitre in the same parcel of fair water, we first evaporated a considerable part of the liquor, and then exposed the remainder to the cold in an earthen vessel; by which means the alum first coagulated at the bottom and sides thereof, in a multitude of eight-sided figures, whilst no crystals of the nitre appeared. Upon further evaporating the liquor, and removing it from the fire, we gain'd more grains of alum, but yet no nitre; we, therefore, evaporated more of the water, till, at length, the nitre plentifully shot into its proper crystals.

A mouse lived for ten minutes, with only a fourth of the natural quantity of the air, and three afterwards.\*

The effect of  
rain; and a  
prognostic  
thereof.

An eminent virtuoso informed me, that in the country of *Campan*, he saw several shallow pits dug for peat, till they came to a kind of quick-

\* Dr. Halley tells us, 'tis found by experiment, that a gallon of air, included in a bladder, and reciprocally inspired and expired by means of a pipe, will become

unfit for farther respiration in little more than a minute. *Philos. Transf.* N<sup>o</sup>. 349. p. 492.

sand,

sand, whereon the rain having fallen for some years, had form'd a kind of clay, from whence good iron was, by skill, attainable. The same person assured me, he had frequently distilled the water of *Campan*, in fine new glasses; and that notwithstanding its rectification, it always left a considerable quantity of stony matter at the bottom. NAT.HIST.

"*Milleffow*, a mountain in *Bohemia*, prognosticates the weather. I once beheld this whole mountain covered with very thick clouds, whilst the other mountains, which stood around it, shew'd no signs of any, and the sun also shone very bright; the inhabitants, however, upon this prepared for foul weather, and advised me to do the like; when in the space of a quarter of an hour, the sky grew cloudy, the sun withdrew his rays, and a prodigious shower ensued. At another time, I found all the mountains about *Milleffow* reek with vapours, while *Milleffow* it self was not affected; when the inhabitants said, they apprehended no mischief from hence, for that *Milleffow* wou'd drink up all those clouds."

"At *Lisle* in *Flanders*, there fell, in the month of *May*, a shower of hail, the smallest stones whereof were as big as pigeons eggs. The storm falling upon the citadel, and the whole town, broke all the windows that faced the wind, laid open the tops of the houses, tore up the trees, spoiled the corn, and killed all the hares and partridges. Some of these hail-stones weigh'd a quarter of a pound, some half a pound, others three quarters, and the largest fort of all above a pound. In the middle of some of them was a brown substance, which put into the fire made a loud noise therein: others were transparent, and immediately melted like lead, when laid before the fire; tho' these were harder than the rest." Large hail.

"In that year the duke of *Tork* last return'd from *Scotland* to *London*, at the upper part of *Galloway* in *Scotland*, there rain'd such a shower of small fishes, exactly resembling herrings in their colour, tast, and form, that they cover'd two acres of land belonging to Sir *Robert Murray* of *Broughton*. This I confirm'd to his royal highness, as having my self seen some of the fishes. His highness ingeniously accounted for the phenomenon, by supposing the whole number raised with the water by a whirlwind, and carried into the air; from whence they afterwards fell by their own weight to the ground." A shower of fish.

# SUSPICIONS

## ABOUT SOME

# HIDDEN QUALITIES

## IN THE

# AIR.

### SECT. I.

**B**ESIDES heat, cold, dryness, moisture, gravity, elasticity, the power of refracting the rays of light, &c. I have often suspected there may be some more latent qualities in the air, different from these, and principally arising from the substantial parts or ingredients whereof it consists. For our atmosphere is a confused aggregate of effluvia from such different bodies, that tho' they all agree in constituting, by their minuteness and various motions, one great mass of fluid matter, yet, perhaps, there is not a more heterogeneous body in the world.

*Subterranean  
effluvia in  
the air.*

'Tis highly probable, that besides those vapours and exhalations which, by the heat of the sun, are elevated into the air, and there afford matter for some meteors, as clouds, rain, parhelions, and rainbows; there are, sometimes, at least, and in some places, plenty of effluvia emitted from the subterranean parts of the terrestrial globe: and 'tis no less probable, that in the subterranean regions there may be many bodies, some fluid, and some consistent, which, tho' of an operative nature, and likely, upon occasion, to emit steams, seldom or never appear upon the surface of the earth; so that several of them have not so much as names assign'd them even by mineralists. Now among this multitude and variety of bodies that lie buried out of sight, who knows but there may be many of a nature very different from those we are hitherto acquainted with; and that as several

won-



wonderful and peculiar operations of the load-stone, tho' a mineral, NAT. HIST. many ages ago famous among philosophers and physicians, were not discover'd till of late; so there may be other subterraneous bodies, endued with considerable powers, which, to us, remain unknown; and would, if known, be found different from those of the fossils wherewith we are hitherto acquainted?

Farther, the sun and planets may have influences here below, distinct from their heat and light. And the subtile effluvia, even of Celestial effluvia in the air. these bodies, may reach our air, and mix with those of our globe in that great receptacle of celestial and terrestrial steams, the atmosphere. The very small knowledge we have of the structure and constitution of globes so vastly remote from us, and our great ignorance of the nature of the particular bodies that may be presum'd to be contain'd in those globes, which, in many things, appear of kin to this we inhabit, leaves room to conjecture, that many of those bodies, and their effluvia, may be of a nature quite different from those we here take notice of\*; and may, consequently, operate after a very different and peculiar manner. And tho' the chief of the heterogeneous effluvia, Effluvia from the operations of the air. that endue the air with secret qualities, may, probably, proceed from beneath the surface of the earth, and from the celestial bodies; yet at some times, and in some places, the air may derive multitudes of efficacious particles from its own operations; acting as a fluid substance upon the vast number and variety of bodies, which are immediately exposed to it. For tho', by reason of its great thinness, and of its being, in its usual state, destitute both of taste and smell, it seems wholly unfit to be a menstruum; yet it may have a dissolving, or at

\* Sir Isaac Newton, after his usual manner, has on a solid foundation carried this thing a surprizing length. "The comet, says he, which appeared in the year 1680. was not, in its perihelion, distant from the sun's body so much as a sixth part of his diameter; and consequently, by reason of its vast velocity at so near an approach, and the density of the sun's atmosphere, it must have suffered some resistance and retardation, by means whereof 'twas drawn nearer to the sun; so that approaching still nearer in every revolution, it must, at length, fall into the body of him. In its aphelion, also, where its motion is exceeding slow, it may, sometimes, be retarded by the attraction of other comets, and afterwards fall into the sun. Thus also the fixed stars, which gradually spend themselves in light and vapour, may be recruited by comets falling into them; and being thus lighted up again, and having new ali-

ment afforded them, may pass for new stars. But the vapours, which arise from the sun, the fixed stars, and the tails of comets, may, by their gravity, fall into the atmospheres of the planets; and there be condensed and turned into water and moist spirits, and thence gradually, by a slow heat, into salts, sulphurs, tinctures, mud, clay, marl, sand, stones, coral, and other terrestrial substances. But as the sun's body decreases, the mean motions of the planets about the sun will, by degrees, be retarded; and as the earth increases, the mean motion of the moon about the earth, will be gradually accelerated: and, indeed, Dr. Halley, from comparing the *Babylonish* observations of eclipses, with those of *Albatagnius*, and the moderns, was the first, that I know of, who observed the mean motion of the moon, compared with the diurnal motion of the earth, to accelerate gradually." *Newton. Princip. p. 480, 481.*

least

**NAT. HIST.** least a consuming power on many bodies; especially such as are peculiarly disposed to admit its operations. For the air has a great advantage, by the vast quantity of it that may come to work, in proportion to the bodies exposed thereto. And in several cases, the quantity of a menstruum may much more considerably supply its want of strength, than chymists seem commonly aware of. There are liquors too, which, tho' they pass for insipid, are not quite destitute of corpuscles fit to act as a solvent; especially if they have time enough to make, with the other parts of the fluid, such numerous and various motions as must bring now some of them, and then others, to hit against the body exposed to them. Thus we find a rust on copper, that has been long exposed to the air; whose saline particles, in time, gradually fasten themselves, in such numbers, to the surface of the metal, as to corrode it, and produce a substance of the colour of verdigrease; which is a factitious body, made of the same metal, corroded by the sharp corpuscles of vinegar, or of the husks of grapes. And by the power which mercury has to dissolve gold and silver, it appears not always necessary, that a fluid solvent should affect the taste. And as to those bodies on which the aerial menstruum can operate, its immense quantity may bring this advantage, that tho' even the strongest menstrua, if they bear no great proportion, in bulk, to the bodies they are to work on, are easily glutted, and being unable to take up any more, leave the rest of the body undissolved; this bears so vast a proportion to the bodies exposed to it, that when one portion of it has impregnated it self as much as 'tis able, there may still come fresh to operate farther on the remaining part of the body.

But besides, the saline and sulphureous particles, that, at least, in some places, may impregnate the air, and give it the greater affinity to proper chymical menstrua, it may, merely as a fluid body, consisting of corpuscles of different sizes, and solidities restlessly and variously mov'd, be, upon account hereof, still dissolving, or preying upon the particles of the bodies submitted to its action. For many of the aerial corpuscles hitting or rubbing every minute against those particles of bodies that chance to lie in their way, may well, by their numerous occurrences and attritions, strike off and carry along with them now some, and then others of their particles; as it happens in water, which, tho' very soft and fluid, wears out such hard and solid bodies as stones themselves, if it often meet them in its passage. The aerial corpuscles, indeed, are very minute, and the bodies exposed to them often large, and seemingly solid; but 'tis not upon the whole body at once, that they endeavour to work, only on the superficial particles, which may often be more minute than those corpuscles. Thus a lump of loaf-sugar, or *Sal gemma*, being cast into common water, tho' this liquor be insipid, and the motions of its corpuscles very languid, yet these corpuscles are able to loosen and carry off the superficial particles of the sugar or salt that chance to lie in their way; and fresh corpuscles of water still succeeding, to work upon the remaining

maining particles of the body that stand in their way, the whole lump is gradually dissolv'd, and ceases to appear to the eye distinct from the liquor. And 'tis not impossible that some bodies may receive a disposition to volatility; and consequently, to pass into the air by the action either of the sun-beams, or of some substance that once issued out of the sun, and reached to our air. For there may be certain bodies, generally in the form of liquors, which, tho' they pass off from some peculiarly dispos'd substances, will, during their stay or contact, produce in them a great and strange aptness to be volatilized; at least, 'tis agreeable to experience, that either upon the accounts abovementioned, or of some others, those parts of the atmosphere, which, in a stricter sense, may be called the air, are in some places so intermixed with particles of different kinds, that among so great a number of various sorts of them, 'tis very likely there should be some kinds of an uncommon and an unobserv'd nature; as might seem probable by the wafting of odorous bodies, and especially camphire; and because some solid bodies actually cold, when their superficial parts are newly taken off, emit, tho' invisibly, such large steams into the air, as continually to grow manifestly lighter upon the balance.

The first phenomenon I shall propose, to strengthen these suspicions, is, the appearance or growth of some salts, in certain bodies which afford them not at all; or nothing near in such plenty, or so soon, unless they be expos'd to the air.

*The growth of salts in bodies exposed to the air.*

Suspecting a solid marcasite, hard as stone, to be fit to make an instance for my purpose, I caus'd it to be broken, that the internal and more shining parts might be expos'd to the air; but tho' this were done in a room where a good fire was usually kept, so that the marcasite was not only sheltered from the rain, but kept in a dry air; yet after a while, I discover'd, upon the glittering parts, an efflorescence of a vitriolic nature. And afterwards meeting with a ponderous, and dark coloured mineral, which at the first breaking discover'd to the eye no appearance of any salt, nor so much as any shining marcasitical particles; we found, nevertheless, that a large quantity of these hard and heavy bodies being kept exposed to the air, even in a room that preserved them from the rain, tho', probably, they had lain many ages entire on the hill wherein they were found; yet in a few months, by the operation of the air upon them, they were in great part crumbled to a powder, exceeding rich in copperas. Nay, having laid up some of these stones in a room where I constantly kept a fire, and in the drawer of a cabinet, which I did not often take out to give them fresh air, most of them were covered with a large efflorescence; which, by its conspicuous colour, between blue and green, by its taste and fitness to make in a trice an inky mixture, with an infusion of galls, sufficiently manifested it self to be vitriol; the growth whereof, by the help of the contact of the air, is the more considerable, because it is not a mere acid salt, but abounds in sulphureous and combustible parts, which



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which I have several times actually separated, or obtain'd from common vitriol, without the addition of any combustible body; and sometimes without any addition at all. It was also uncommon, that our blackish minerals required no longer time, nor any rain, to make them afford their vitriolic efflorescencies; for I kept many of those marcasites, both glittering ones and others, of which they make great quantities of vitriol at *Deptford*, without perceiving in them a change, that came any thing near to what I have mentioned. And I have observed those whose trade it is to make vitriol, are often oblig'd to let their vitriol-stones, as they call them, lie for half a year, nay, sometimes two years, exposed not only to the open air, but to the rain and sun, before they can obtain from them their vitriolic parts.

That also the earth, or ore of alum, robb'd of its salt, will, in tract of time, recover it, by being exposed to the air, we are assured by the experienced *Agriola*. I have likewise observed, that some kind of lime in old walls and moist places, has, in time, gain'd a large efflorescence, very much of a nitrous nature; as I was convinced, by having obtain'd salt-petre from it, upon barely dissolving it in common water, and evaporating the filtred solution: and also in calcined vitriol, whose saline parts have been driven away by the violence of the fire, particles of fresh salt may be found, after it has lain a competent time in the air.

But tho' these and the like observations have generally pass'd, without being call'd in question; yet it seems to me somewhat doubtful, whether the salts that appear in the forementioned cases, are really produced by the operation of the air working as an agent, or also concurring as an ingredient; or whether these saline substances proceed not from some internal thing, analagous to a seminal principle; causing in them a kind of maturation of some parts; which being once ripen'd, and perhaps assisted by the moisture of the air, disclose themselves in the form of saline concretions; as in the feculent or tartarous part of wines, there will, in tract of time, be generated or produced, numerous corpuscles of a saline nature, that give the acid tast we find in tartar, especially in that of *Rhenish* wine. It may also be suspected, that the salts found in marcasites, in nitrous and aluminous earths, &c. are made by the saline particles of the like nature; that among multitudes of other kinds swim in the air, and are attracted by the similar particles yet remaining in the terrestrial bodies, which are, as it were, the wombs of such minerals; as spirit of nitre will with fixed nitre, and some other alkalies, compose salt-peter; or else, that such aerial salts, assisted by the moisture of the air, soften, open, and almost corrode, or dissolve the more terrestrial substance of these wombs, and thereby sollicit and extricare the latent saline particles; and by their union with them, compose those resulting bodies that resemble vitriol, alum, &c. However, if a convenient quantity of nitrous earth,

earth, or other proper substance, be kept in a close vessel, whereto the air has no access, for as long a time as has been observ'd sufficient to impregnate the like substance, or a portion of the same matter that was included, it may help to remove our scruples; for if the body that was kept close, have either gain'd salt at all, or very much less in proportion to its bulk, than that which was kept exposed, we may thence learn, what is to be ascribed to the air in the production of nitre, or other saline concretions. And having observed none of these bodies, that would so soon, and so manifestly even to the eye, disclose a saline substance, as the blackish vitriol-ore before mentioned; I judged this a very fit subject, wherewith to try what maturation, or time, the air being secluded, wou'd do in this case. Accordingly, having taken some fragments of it, which we carefully freed from the adhering vitriolic efflorescence, we put of different sizes of them into two conveniently shap'd glasses, which being hermetically sealed, were order'd to be kept in fit places; by which means 'twas expected, that even, without opening the glasses, we should be able easily to see, by the changed colour of the superficial parts, whether any vitriolic efflorescence was produced; but thro' the negligence, or mistake, of those to whom the care was recommended, the experiment was never brought to an issue. Tho' after some time I perceiv'd, that notwithstanding the glass had been so closely stopp'd, there plainly appeared on the outside of the mass, some grains of an efflorescence; whose colour, between blue and green, argued it to be of a vitriolic nature. But although, till the success of some such trial be known, I dare not confidently pronounce about the production or regeneration of salts, in bodies that have been robb'd of them, and ascribe it wholly to the air; yet when I consider the several great effects of the air upon several other bodies, I think it not rash to conjecture, in the mean time, that the operations of the air may have a considerable share in these phenomena; and so, that there may be latent qualities in the air; these qualities being understood *in concreto*, together with the substances, or corporeal effluvia, wherein they reside. And of such aerial qualities, taken in this sense, I shall now proceed to mention some other instances.

The difficulty we find in keeping flame and fire alive, tho' but for a little time, without air, renders it suspicious, that there may be dispersed thro' the rest of the atmosphere, some odd substance, either of a solar, astral, or other foreign nature; on account whereof the air is so necessary to the subsistence of flame. And this necessity I have found to be more considerable, and less dependent upon the manifest attributes of the air, than is usually observ'd; for by trials purposely made, it has appear'd, that a small flame of a lamp, tho' fed perhaps with a subtil, thin oil, wou'd in a large glass-receiver expire for want of air, in a far less time than one wou'd believe. And it will not much lessen the difficulty to alledge, that either the gross fuliginous smoke in a close vessel stifled the flame, or that the pressure of the air is requisite to

*Astral substance in the air.*

**NAT. HIST.** impel up the aliment into the wieck; for to obviate these objections, I have, in a large receiver, employed a very small wieck, with such rectified spirit of wine, as wou'd in the free air burn totally away; yet when a very small lamp, furnished with such a very slender wieck, was made to burn, and, filled with this liquor, was put lighted into a large receiver, that little flame, tho' it emitted no visible smoke at all, wou'd usually expire within about one minute, and often in less; and this tho' the wieck was not so much as sing'd by the flame: nor indeed is a wieck necessary for the experiment, since highly rectified spirit of wine will, in the free air, flame away without it. And it seems surprizing, what that should be in the air, which enabling it to keep flame alive, does yet, by being consum'd or deprav'd, so suddenly render the air unfit to preserve flame. It also seems by the sudden wasting or spoiling of this fine substance, whatever it be, that the bulk of it is but very small in proportion to the air it impregnates with its vertue: for after the extinction of the flame, the air in the receiver was not visibly alter'd; and, for ought I could perceive by several ways of judging, the air retained either all, or at least the far greatest part of its elasticity; which I take to be its most genuine and distinguishing property. And this undestroy'd springyness of the air, with the necessity of fresh air to the life of hot animals, suggests a great suspicion of some vital substance, if I may so call it, diffused thro' the air; whether it be a volatile nitre, or rather, some anonymous substance, sideral or subterranean; tho' not improbably of kin to that which seems so necessary to the maintenance of the other flames.

By keeping putrefied bodies in glasses hermetically seal'd, and thereby secured from the contact of the external air, I have not been able to produce any insect, or other living creature; tho' sometimes I have kept animal substances, and even blood, so included for many months; and one or two of them for a longer time; and tho' these substances had a manifest change made in their consistence, whilst they remain'd seal'd up. I shall here add another observation, that I met with in a little dissertation, *de admirandis Hungariae aquis*, written by an Hungarian nobleman; where speaking of the native salt which abounds in their regions, he says that "in the chief mine of *Transylvania*, called *De-sensis*, there was, a few years before he wrote, a great oak, like a " huge beam, dug out of the middle of the salt; but tho' it was so " hard, that it could not easily be wrought upon by iron tools, yet " being expos'd to the air out of the mine, it became so rotten, that " in four days it was easy to be crumbled between the fingers." And of that corruptive, or dissolutive power of the air near those mines, the same author mentions other instances.

Seminal corpuscles in the air.

Having found an antimonial preparation to prove emetic, in a case where I did not at all expect it; I enquired of some physicians and chymists of my acquaintance, whether they had not taken notice, that *Antimonium diaphoreticum* wou'd become vomitive, if 'twere not kept from



from the air? And more than one physician assured me, it wou'd; as they had found by particular trials. I find also, that the experienced *Zwelfer* gives a caution against letting the air come at these antimonial medicines; lest it should render them, as he says it will in tract of time, not only emetic, but dispos'd to produce heart-burnings, faintings, and other bad symptoms. And I learnt from a very ingenious physician, that having carefully prepared *Antimonium diaphoreticum*, he gave many doses of it whilst it was fresh, and kept stopt in a glass, without finding that in any patient it procured one vomit; but having kept a parcel of the same remedy for a considerable time, in a glass, only cover'd loosely with a paper; the medicine, vitiated by the air, prov'd strongly emetic to those, who neither by constitution, nor foulness of stomach, or on any other discernable account, were more than others that had taken it, dispos'd to vomit. By which observations, and what I before remark'd of salt-peter obtainable from lime, it should seem, as if either there were in the air a substance dispos'd to be assimilated by all kinds of bodies; or that the air is so vast and rich a magazine of innumerable seminal corpuscles, and other analogous particles, that almost any body long expos'd thereto, may there meet with particles of kin to it self, and fit to repair its injuries and losses, and restore it to its natural state.

*M. de Rochefort*, in the account he gives of the fruit of the tree *Junipa*, the juice whereof is employ'd by the *Indians* to black their skins, that they may look the more terrible to their enemies, observes, that tho' the stain or tincture of this fruit cannot be wash'd out with soap; yet within nine or ten days it will vanish of it self: which wou'd make one suspect, that there may be in the air some secret, powerful substance, that renders it a menstruum of more efficacy than soap it self, to take away stains. I have seen this fruit, but not whilst it was juicy enough to have a trial made with it, which I should have been glad of, because the author does not clearly express, whether this disappearing of the tincture happens indifferently to the bodies it chances to stain, or is only observed on the skins of men: for as in the former case 'twill afford an instance pertinent to our present purpose; so in the latter, I should suspect, that the vanishing of the tincture may be due, not so much to the operation of air upon it, as to the sweat and exhalations of a human body; which abounding with volatile salt, may either destroy, or carry off with them, the colour'd particles they meet with in their passage.

I have sometimes, with wonder, observ'd the excellency of the better sort of *Damasco* steel, in comparison of ordinary steel. And there is one phenomenon, which, tho' I am not sure it belongs to the latent qualities of the air, yet because it very well may, I will here relate it. Having enquired of an eminent and experienced artificer, whom I employ in some difficult experiments, about the properties of *Damasco* steel; the honest, sober man, averr'd to me, that when he made instruments

*A lixivious property in the air.*

*A power in the air to change the texture of metals.*

**NAT. HIST.** of it, and gave them the true temper, which is somewhat different from that of other steel, he generally observed, that, tho' when razors, &c. made of it, were newly forg'd, they would be, sometimes, worse than those of other steel; yet when they had been kept for a year, or two, or three in the air, tho' nothing else was done to improve them, they would much surpass other instruments of the same kind, and what themselves were before; so that some of them have been laid aside, at first, as no ways answering the great expectation conceived of them, which, after two or three years, they were found to exceed. And I have several times made a substance, that consists chiefly of a metalline body, and is of a texture so close as to lie for many hours undissolved in a corrosive menstruum; yet this substance, that was fixed enough to endure melting by the fire, without losing its colour, would, when I had purposely exposed it to the air, be dissolved in a very short time, and have its superficial parts turn'd almost black.

*Changes of colour introduced by the air.*

And this brings to mind the very pretty observation, newly made in *Italy* by an ingenious man, who took notice, that, if after the opening of a vein, the blood be kept till it be concreted, and have excluded the superficial serum, tho' the lower part be usually of a dark and blackish colour, in comparison of the superficial parts, and therefore be counted far more feculent; yet if the lump or clot of blood be broken, and the internal and dark colour'd parts of it exposed to the air, it will, after a time, be so wrought on thereby, that the new superficial part will appear as florid as the the upper part seemed before. And this observation I found to hold in the blood of some beasts, whereon I tried it; but I have found it to succeed in much fewer minutes than the *Italian* experiment, on human blood, made me expect.

*A power in the air, both of dissolving and coagulating the same body.*

On the other side, I have often prepared a substance, wherein the effect appears quite contrary to this. For tho' the factitious concrete, whilst kept to the fire, or very carefully preserv'd from the air, be of a red colour, almost like the common opake bloodstone of the shops, yet if I broke it, and left the lumps in the air, it would, in a short time, perhaps, in less than a quarter of an hour, have its superficial parts turned of a very dark colour, sometimes scarce at all short of blackness.

A very inquisitive person, of my acquaintance, making, by distillation, a medicine of his own devising, chanc'd to observe this odd property in it, that if it were kept stopp'd, it would be coagulated almost like oil of aniseed, in cold weather; yet if the stopple were taken out, and access for a while given to the air, it would turn to a liquor, and the vessel being again stopp'd, it would, tho' more slowly, coagulate again. And desiring to see this odd preparation, I found it, when brought into the room where I was, not liquid, but consistent; tho' of a slight and soft texture. And having taken out

out the cork, and set the viol in a window, tho' the season, being NAT. HIST.  
 winter, was cold; yet, in a little time, I found the coagulated substance almost become fluid. And another time, when the season was less cold, being where the vial was kept well stopp'd, and casting my eyes on it, I perceived the included substance to be coagulated much like oil of aniseed. And this substance having, as the maker assured me, nothing at all of mineral in it, nor any chymical salt; but consisting only of two simple bodies, the one a vegetable, and the other an animal substance, distill'd together; these contrary effects of the air, (which seems to have a power, in some circumstances, to coagulate such a body, and yet to dissolve and make it fluid, when fresh parts are allow'd access) may deserve to be farther reflected on, with regard to the seasonable operations the inspired air may have on the consistence and motion of the circulating blood, and to the discharge of the fuliginous recrements to be separated from it in its passage thro' the lungs.

There are two other phenomena which seem favourable to our suspicion, there being anonymous substances and qualities in the air: the one is, the growth or apparent production of metals and minerals dug out of the earth, and exposed to the air. But of this we shall treat more particularly hereafter; tho' the caution formerly given about the regeneration of salts in nitrous and other earths, may, *mutatis mutandis*, be applied to this production of metalline and mineral bodies. The other phenomenon is afforded by the various and odd contagious diseases, that at some times, and in some places, invade and destroy numbers of beasts, sometimes of one particular kind, and sometimes of another. Of this we have many instances in the books of approved authors, both physicians and others; and I have my self observed some notable examples of it. Probably the subterranean parts of the earth, sometimes, especially after earthquakes, send up into the air peculiar kinds of venomous exhalations that produce new and mortal diseases, in animals of a particular species, and not in those of another; and in this, or that particular place, and not elsewhere; of which we have an eminent instance in that odd plague, or murrain, of the year 1514; which *Fernelius* tells us, invaded none but cats. And even in animals of the same species, sometimes one sort has been incomparably more obnoxious to the plague than another. *Dionysius Halicarnassensis* mentions a plague that attack'd none but maids: and the pestilence, that raged in the time of *Gentilis*, a fam'd physician, kill'd but few women, and scarce any but lusty men. *Boterus*, also, mentions a great plague, that assaulted almost only the younger sorts of persons; few past thirty years of age being attack'd by it; which last observation has been, also, made by several late physicians. We may add, what learned men of the faculty have noted, at several times, concerning plagues, that particularly invade those of this or that nation, tho' confusedly mix'd with other peo-

Contagious  
 diseases occa-  
 sioned by the  
 air.



**NAT. HIST.** people. Cardan speaks of a plague at *Basil*, with which only the *Switzers*, and not the *Italians*, *French*, or *Germans*, were infected. And *Johannes Urenhorvius* takes notice of a cruel plague at *Copenhagen*, which, tho' it rag'd among the *Danes*, spared the *English*, *Dutch*, and *Germans*; who freely enter'd the infected houses, and were not careful to avoid the sick. But I must not be understood to impute these effects merely to the noxious subterranean fumes; for I am far from denying, that the peculiar constitutions of men are likely to have a great share in them; yet it seems less probable, that the pestilential venom, diffused thro' the air, should owe its enormous and fatal efficacy to the excess of the manifest qualities of the air, than to the peculiar nature of the pestilential poison breath'd from the bowels of the earth; which poison, when it is, by dilution, or dissipation, enervated; or by its progress, past beyond the air we breathe in, or render'd ineffectual by subterranean or other corpuscles of a contrary quality, the plague, which it produced, either quite ceases, or degenerates into somewhat else. And thus, perhaps, some of those diseases, called new, which either began to appear, or raged within these two or three centuries, as the sweating-sickness, in the fifteenth century, the scurvy and the *Morbus Hungaricus*, the *Lues Moravia*, *Novus morbus Luneburgensis*, and some others, in the last century, may be in part caused by the heterogeneous steams we are here considering.

Uses of this doctrine of subterranean and celestial effluvia in the air.

And now if our two suspicions about subterranean and siderial effluvia shall prove well grounded, they may lead us to farther thoughts about things of no mean consequence; three of which I shall here mention. And 1. we may hence take occasion to consider, whether several changes of temperature and constitution in the air, both as to manifest and latent qualities, may not, sometimes, be derived from the scarcity, or plenty, and peculiar nature of one or both of these sorts of effluvia. We find, in the most approved writers, such strange phenomena to have, several times, happen'd in great plagues and contagious diseases, fomented and communicated, nay, began by some latent pestiferous, or other malignant constitution of the air, as have obliged many of the most learned of them to have recourse to the immediate operation of the angels, or of the power and wrath of God himself; or at least to some unaccountable influence of the stars. But none of these solutions seem preferable to what may be gather'd from our conjecture; since of physical agents, whereof we know nothing so much as that they are to us invisible, and, probably, of a heterogeneous nature; it need be no great wonder, that the operation should, also, be abstruse, and the effects uncommon. And there are clearer inducements to persuade us, that another quality of the atmosphere, its gravity, may be alter'd by unseen effluvia ascending from the subterraneous regions of our globe. We have often perceived, by the mercurial barometer, the weight of the air to be

be considerably increased, when we could not perceive in the air, nor NAT. HIST.  
 surface of the earth, any cause to which we might ascribe so great a change. And I have sometimes doubted, whether even the sun it self may not now and then alter the gravity of the atmosphere, otherwise than by its rays or heat. I desired some gentlemen of my acquaintance to assist me to discover, whether some of the spots that appear about the sun, may not, upon their sudden dissolution, have some of their dispers'd matter thrown off as far as our atmosphere; and that in a quantity sufficient to produce some sensible alterations in it, at least as to gravity.

2. Another thing which our two forementioned suspicions, if allow'd of, will suggest, is, that possibly some bodies we are conversant with, may have a peculiar disposition and fitness to be wrought on by, or to be associated with some of those foreign effluvia, emitted by unknown bodies, lodg'd under ground, or that proceed from some particular planet. For what we call antipathies, depending really, on the peculiar textures, and other modifications of the bodies, between which these friendships and hostilities are said to be exercis'd, I see not why it is impossible, that there should be an affinity betwixt a body of a fit or convenient texture, especially as to the shape and size of its pores, and the effluvia of any other body, whether subterranean or sidereal. We see, that convex burning glasses, by virtue of their figure, and the disposition of their pores, are fitted to be pervaded by the rays of light, and to refract them, and thereby to kindle combustible matter; and the same rays of the sun will impart a splendor to the *Bolonian* stone. And as for subterranean bodies, we have sometimes shewn, that two minerals being prepared in a peculiar manner, the steams of the one ascending without adventitious heat, and wandering thro' the air, will not sensibly work on other bodies; but if they meet with a body that we prepared, they immediately operate upon it; and the effect will be both manifest and lasting.

3. The third thing suppos'd by our suspicions is, that if they are well founded, it may be consider'd, whether among the bodies we are acquainted with here below, there are not some that may prove receptacles, if not also the attractives of sidereal, and other foreign effluvia, that rove up and down in our air. By attractives, I here mean, such magnetical bodies as are fitted to detain, and join with effluvia; when, by virtue of the various motions that belong to the air as a fluid, these happen to accost them. Thus in making oil of tartar *per deliquium*, tho' the fiery salt is suppos'd to draw to it the aqueous vapours, yet indeed it does but arrest and incorporate with such of those that wander thro' the air, as come in their passage to accost it. And without receding from the corpuscularian principles, we might allow some of the bodies we speak of a great resemblance to magnets; which may, upon the bare account of adhesion, by juxta-position, or contact, detain the effluvia that wou'd glide along them; and these may be the more firmly.

**NAT. HIST.** firmly arrested, by a kind of precipitating faculty of the magnet, with regard to such effluvia; nay, 'tis possible in some circumstances of time and place, that one of our magnets may, as it were, fetch in such steams, as wou'd indeed pass near it, but wou'd not otherwise come to touch it. Thus I have made bodies, not all of them electrical, attract, without being excited by rubbing, &c. far less light bodies than the effluvia we are speaking of.

## S E C T. II.

*Celestial and  
aerial mag-  
nets.*

**S** EVERAL bodies, which experience assures us imbibe or retain something from the air, as calcined minerals, marcasites, salts, factitious and natural, &c. may be often expos'd to it, and then weigh'd again, and farther diligently examined, whether that which makes the increase of weight be a mere imbibed moisture, or somewhat else; and likewise, whether it be separable from the body or not, or have endow'd it with any considerable quality. And experiments may be varied with a good magnet, by exposing it long to the air, in regions differing much in climate, soil, or both; by exposing it by day only, or by night, at several seasons of the year, in several temperatures of the air, at several considerable aspects of the stars and planets, by making it more or less frequently part with what it has gained from the air; and in short, by having regard to that variety of circumstances which human sagacity will suggest. For by thus diversifying the experiment many ways, we may, perhaps, by one or other of them, make some unexpected, and yet important discovery, of the effluvia wherewith the air in particular places, at particular times, abounds; and perhaps too of some correspondence between the celestial and terrestrial globes of the world.

These, perhaps, will seem extravagant thoughts; but if I had been fortunate in preserving all my observations, or other fruit, of some experiments I once made of this kind, it wou'd keep them from appearing ridiculous. To shew, however, that the air may not only have a notable operation upon vitriol, even after a strong fire could work no farther on it; and that this operation was considerably diversify'd by circumstances; I shall make use of an observation of the experienced *Zwelfer*, who informs us; that "the colcothar of this mineral, made by a strong distillation, is not corrosive; and that no salt can be obtained from it soon after distillation, by the affusion of water; but, says he, if it be for some time expos'd to the air, it will yield a salt, which is sometimes white, sometimes of a beautiful purple colour; and this I have obtain'd in large quantities, and sometimes also a nitrous kind."

This



This testimony has much the more weight with me, because I find what he affirms of the saltlessness of vitriol, newly and strongly calcined, to be very agreeable to some of my experiments upon colcothar of blue vitriol; which is so odd a concrete, that I more than once recommended the making experiments upon it to several curious persons; one of whom, an industrious man, and vers'd in chymical operations, assured me, that not only he had different kinds of salts from colcothar expos'd to the air for many months, and robb'd at convenient times of what it acquired; but that in tract of time he found it so alter'd, that he obtain'd from it a considerable quantity of true running mercury.

But there are two or three things that I wou'd desire to be observ'd about this odd *Caput mortuum*. The first is, that some circumstances be regarded, which most observers wou'd overlook; such as the temperature of the air, the month of the year, the winds, the weight of the atmosphere, the spots of the sun, the moon's age, her place in the zodiac, and the principal aspects of the planets, and other chief stars: for tho' it be a boldness to affirm, that any, or perhaps all these together, will be concern'd in the production of the salt, or other substance to be made or disclos'd in the colcothar; yet in things new and exorbitant, it may be sometimes rash and peremptory, to deny even such particulars as cannot without rashness be positively asserted; and in our case, the small trouble of taking notice of circumstances, will be richly rewarded, by the least discovery made in things so abstruse and considerable. And as we cannot yet pronounce so much as negatively, whether the libration of the moon, and the motion of the sun, and perhaps of some of the other planets, about their own centers, and consequently their turning several parts of their bodies to us, may have an operation upon our atmosphere; so, for ought I know, there may be in those vast internal parts of the earth, whose thin crust only has been here and there dug into, considerable masses of matter having periodical revolutions, accensions, estuations, fermentations, or in short, some other notable commotions; whose effluvia may produce effects yet unobserv'd on the atmosphere, and on some particular bodies expos'd to it; tho' these periods may, perhaps, be altogether irregular, or have some kind of regularity, different from what one wou'd expect. Thus the sea has those grand intumescencies, we call spring-tides, not every day, nor at any constant day of the month or week, but about the full and new moon; and these spring-tides are most notably heighten'd, not every month, but twice a year; at or about the vernal and autumnal equinoxes: which observations are not near so ancient, and so well known, as the daily ebbing and flowing of the sea. The etesians of the ancients I shall not now insist on, nor the observations of the elder inhabitants of the *Caribbee* islands; who, when the *Europeans* first resorted thither, had hurricanes but once in seven years; afterwards they were molested with them once in three years; and of late they are troubled with them almost every year. And a physician who lived there, told

Observation  
to be made on  
colcothar.

NAT. HIST. me, he had scarce ever observ'd them to succeed one another in a less compass than of two months. In which instances, and several others that may be noted, of what changes happen to great quantities of matter, nature seems to affect something of periodical; but not in a way that appears to us regular. We may add, what the learned *Varenius* relates of those hot springs in *Germany*, he calls *Therma piperina*, of which he affirms this peculiarity, that they annually begin and cease to flow at certain seasons; the former about the 3<sup>d</sup> of *May*; and the latter near the middle of *September*; from which time they rest till the following spring. And *Johannes de Laet* tells us, that "in the *Mexican* province *Xilotepec*, there is a spring which runs for four years successively, and remains dry for the four following; when it again breaks out afresh; and which, says he, is strange, it affords less water on rainy days, than it does in clear, dry weather."

And thus much may invite us to take notice of circumstances in our observations on colcothar; which might with the greater hopes of success be kept long expos'd, because bars of windows, and other erect irons, have been found in tract of time to acquire a settled magnetism from the effluvia of the earth.

The other principal thing I wou'd recommend is, that notice be taken not only of the kind of vitriol, whereof the colcothar is made, as whether it be blue *Dantzick* vitriol, vitriol of iron, *Hungarian*, *Roman*, &c. but also to what degree the calcination is made, and how far the calcin'd matter is freed from the salt by water. For these circumstances, at least in some places, will be of moment, and may perhaps afford hints of the constitution of the atmosphere in particular parts, as well as of the best preparation of colcothar for detaining the foreign effluvia. And I wou'd the rather have experiments try'd again in other places with colcothar not calcin'd to the utmost, nor yet so exquisitelyedulcorated, but that some saline particles shou'd be left in it for future increase; because I have more than once purposely try'd, in vain, that the *Caput mortuum* of blue vitriol, whereof the oil and other parts had been driven off with a violent and lasting fire, wou'd not, when fresh, impart any saltiness to water; nor do I think, that out of some ounces purposelyedulcorated, I obtained one grain of salt: and this insipid colcothar being expos'd, some by me, and some by a friend who had conveniency in another place not far off, to the air, some for many weeks, and some for several months; we did not find it to have manifestly increas'd in weight, or to have acquired any sensible saltiness; which, supposing the vitriol to have nothing extraordinary, gave me the stronger suspicion of some peculiarity in the air of that part of *London*, where the trials had been made; at least, during those times wherein we made them; because not only former experiments made here in *England* had assured me, that some colcothars will gain a considerable addition of weight, by being expos'd to the air; but accidentally complaining of my disappointment to a traveller, who had in many countries

exa-

examined their vitriols, assured me, that tho' he usually dulcify'd his colcothar very well, yet within 4 or 5 weeks he found it considerably impregnated by the air whereto it was expos'd. NAT. HIST.

It remains, that I add one intimation more about vitriol; for since it has so great a correspondence with the air, as I have found, it wou'd not be amiss to try, not only colcothar of different vitriols, whether barely made the common way, or without any metalline addition to the vitriol-stones or ore; but other preparations of it too, as by exposing vitriol, only calcined to whiteness by the sun-beams; or further to an higher colour, by a gentle heat, or thoroughly calcined, and then impregnated with a little of its own oil: for such vitriolic substances as these the air may work upon; nay, even liquid preparations of vitriol may be peculiarly affected by the air, and thereby perhaps be useful to discover the present constitution, or foretel some approaching changes of it.

In making a composition with sublimate, copper, and spirit of salt, whereby I obtained a liquor of a beautiful green, I found the air had so much interest in the production of the colour, that when I had made the solution of the copper and mercury with the spirit of salt, that solution was not so much as greenish, as long as I kept it stopp'd in the glass wherein 'twas made: but if poured into a vial, which not being stopp'd, leaves it expos'd to the air, it after a while obtains that delightful green we spoke of. This experiment I repeated several times, and found the solution, till the air made it flourish, to be of a muddy reddish colour; so that having once kept some of the liquor, in the same glass egg wherein the solution had been made, it look'd like very dirty water; whilst the other part of the same solution, having been exposed to the air, resembled the colour of an emerald. In which change 'tis remarkable, that to clarify this liquor, and give it a transparent greenness, I perceiv'd not that any precipitation of foul matter was made, to which the alteration cou'd be ascribed; yet to render it the more manifest, that this change proceeded not from a subsidence made of some darkening matter, effected by rest; I kept some of the solution sealed up in a fine vial for several months, without finding it at the end of that time other than of a dark or muddy colour; which it soon ceas'd to be, when the hermetic seal being broken off, the air was permitted to work upon it. And I further observed in our various experiments on this liquor, that according to the quality of the matter, and other circumstances, the greenness was not attain'd to but at certain periods of time; now and then disclosing it self within two or three days, and sometimes not till after nine or ten.

The method of making this green liquor being troublesome, the following may serve in its stead; tho' perhaps it will not succeed so constantly as the other. We took, more than once, filings of clean, crude copper, and having put on them a convenient quantity of good spirit of salt, we suffer'd the menstruum to work upon the metal, which it usually

*A great effect  
of the air in  
producing co-  
lour.*



NAT. HIST.

does slowly, and not like *Aqua fortis*. When the liquor had, by this operation, acquir'd a thick, muddy colour, we decanted it into a clean wide-mouthed glass, which being left for a competent time in the open air, the exposed liquor became of a fair green; tho' it did not appear that any thing was precipitated at the bottom to make it clear.

With how little confidence of success, trials that have the aims of these are to be attempted, consideration and experience have made me sensible; yet I would not discourage mens curiosity from venturing even upon slight probabilities, where the design and the nobleness of the subject may make even small attainments very desirable. And till trials have been made, on occasions of great moment, 'tis not easie to be satisfied, that men have not been wanting to themselves. What experiments I have made, relating to this subject, I shall here set down.

Experiments:  
as manifest  
some latent  
qualities in  
the air.

1. Having occasion to dulcify some calx of *Dantzick* vitriol, from which the oil had been long before distilled; water was put upon two large portions of it, that the liquor might be impregnated with the vitriolic particles remaining in the calx; the water, put upon one of these portions, was, soon after, being sufficiently impregnated, filtered, and gently abstracted; by which means it afforded a kind of salt of vitriol, that seem'd to differ very little from the vitriol which had been calcined. But the water, put upon the other portion of calcin'd vitriol, was, in a wide-mouth'd vessel, left in the air for a month or six weeks, after which time, when it came to be abstracted, it afforded many drams of a salt, that did not then, nor long after, look at all like common vitriol, or like the other; but shot white, almost like salt-peter, or some other untinged salt. Whether this experiment will constantly succeed, and at other seasons of the year than in the summer, wherein 'twas made, I had not the opportunity to try fully. But that the air may have a great share, in varying the salts, obtainable from calcined vitriol, seems the more probable, because we had a parcel of colcothar that had lain for some years in the air, shelter'd from the rain; and causing a lixivium to be made of it, we found, when the superfluous moisture was exhaled, that its saline particles began to shoot into salt far more white than vitriol, and very different from it in its figure and way of concretion.

2. Exactly weighing an ounce of the colcothar of vitriol of copper, carefully dulcified, and left in my study at *Oxford*, during the months of *January* and *February*, and exposing it to the air for some weeks, we found it to have thereby gained four grains, and about a quarter, besides some little dust that stuck to the glass. This experiment, compared with the following, will shew, that the difference of airs, seasons, calces of vitriol, or other circumstances, may produce a notable disparity in the increase of the weight gain'd by the bodies exposed to the air.

3. We

3. We put eight ounces of foreign vitriol, calcined to a deep redness, into a broad flat metalline vessel, and set it upon a shelf, in a study that was seldom frequented; and at the same time, to observe what increase would be made by exposing to the air a larger superficies of the powder, with regard to its bulk, we put into another metalline vessel, smaller than the other, only two ounces of colcothar, and set it on the same shelf with the other. This was done on *March 12*; and on *June 25* we weigh'd these powders again, and found the eight ounces to have gained one dram and seventeen grains; and the two ounces had acquired the same weight within a grain; then putting them back into their former vessels, we left them in the same place, as before, till *August 24*; when we found cause to suppose, that the greater parcel of colcothar had met with some mischance, either by mice or otherwise; but the less weighed twenty six grains heavier than it did in *June*, amounting now to two ounces one dram forty two grains; having increased in less than six months above a hundred grains, and consequently, above a tenth part of its first weight. No trial was made to discover what this acquired substance might be, lest we should thereby disturb the intended prosecution of the experiment.

4. Because in most of these experiments of substances exposed to be impregnated by the air, or to detain its saline or other heterogeneous particles, we employed bodies prepared and much altered by the operation of the fire, we thought fit to make some trials with such as were unchang'd by the fire; and to this purpose, we took several small lumps of a marcasite, which was partly of a shining, and partly of a darkish colour, and which seemed well disposed to afford vitriol, amounting to two ounces; these were kept in a room where they were freely accessible to the air, which was esteemed to be very pure. After the marcasites had been kept in this room, somewhat less than seven weeks, we weighed them again, in the same balance, and found the two ounces increas'd by above twelve grains.

5. I once or twice observ'd the fumes of a sharp liquor to work more suddenly or manifestly on a certain metal, sustain'd in the air, than did the menstruum it self that emitted those fumes on those parts of the metal it covered. And a chymist, who had been in *Hungary*, and other parts, purposely to visit mines, assured me, that as to the ladders and other wooden work, employed in one or more of the deep *Hungarian* mines, those that were in the upper part of the grooves, near the external air, would, by the fretting exhalations, be render'd unserviceable, in a few months; whilst such ladders, pieces of timber, &c. which were employed in the lower part of the mine, would hold good for two or three times as long.

6. A certain soft but consistent body, about the bigness of a nutmeg, chymically prepared, and which, in the free air, would continually emit a thick smoke, being put into a vial, and placed in a middle siz'd receiver on our pneumatic engine, continued for some time to afford

NAT. HIST.

afford manifest fumes, whilst the air was exhausting, till at length the visible ascent of fumes, out of the vial, quite ceased; and the matter having remained for some time in this state, the smoking substance was so altered as to emit no more fumes, not only when the air was let into the receiver, but for a considerable time after the vial was taken thence, till it had been removed to the window; where the wind blowing in fresh air, it began to smoke as formerly. And this substance having been kept in a large glass, into which it was distill'd, at least for five or six weeks, would smoke very plentifully upon the contact of the air, yet be kept from smoking, tho' the chymical receiver were stopp'd but with a piece of paper. Nay, farther, when a vial, containing some of it, was put, unstopp'd, in the receiver of our air-pump, close luted on, tho' no exhaustion were made, yet the white fumes immediately ceas'd to ascend, as if the smoke participated of the nature of flame, and presently glutted the air, or otherwise made it unfit, without diminishing its gravity, to raise the body.

*The growth  
of metals ex-  
posed to the  
air in their  
ore.*

Let us next consider the generation of metals. But I design not to examine, whether metals and minerals, as if they were a kind of subterranean plants, properly grow like vegetables; I here take the growth of metals in a loose popular sense, wherein a metal may be said to grow, if an assigned portion of matter, which yet either discovers no metal, or but such a quantity, as, being exposed to the air, will, after a time, afford some, or a greater proportion than it had before.

*The growth  
of tin.*

An ancient owner of mines assured me, he could, otherwise than upon vulgar conjecture, prove, that minerals grow even after the veins have been dug; and being desired to let me know his proofs, he gave me these that follow: first, he said, that not far from his house there was a tin-mine, which the old diggers affirmed to have been left off, some said eighty, some a hundred and twenty years ago; because they had, by their washing and vanning, separated all the ore from the rest of the earth; yet, of late years, they found it so richly impregnated with metalline particles, that it was wrought over again with very great profit, and prefer'd to some other mines that were first wrought without having been ever so robb'd. And when I objected, that, probably, this might proceed from the laziness and unskilfulness of the workmen in those times, who left in the earth, the tin that was, or might be separated; he answered, 'twas a known thing in the country, that in those times the miners were more careful and laborious to separate the metalline part from the rest of the ore than now. He also affirmed, that in his own time, some tenants and neighbours of his, having got all the ore they could from a great quantity of stuff dug out of a tin-mine, they laid the remains in large heaps, exposed to the air, and, within twenty five years after, found them so richly impregnated, that they wrought them over again,



again to better advantage. And, lastly, he assured me, that in a work of his own, wherein he had exercis'd his skill and experience to separate all the particles of the tin, from the terrestrial substances dug up with it out of the vein, he caus'd dams to be made to stop the earthy matter which the stream wash'd away from the ore, giving passage to the water, after it had let fall this substance; which lying in heaps expos'd to the air, within 10 or 12 years, and sometimes much less, he examin'd this or that heap, and found it to contain such store of metalline particles, as invited him to work it again, which he did with profit. Yet this gentleman was so dextrous at separating the metalline, from the other parts of tin-ore, that I cou'd not without wonder see what small corpuscles he wou'd, to satisfy my curiosity, sever from vast quantities of earthy and other mineral stuff.

Relations agreeable to these I received from another very ingenious gentleman, who was skill'd in tin-mines, and lived not far from several of them.

I was the more solicitous to procure an information about the growth of this metal, because the greatest part of that used in *Europe*, being met with in *England*, I have found no mention made of the growth of it in foreign writers.

A person of quality, who had a patent for several lead mines, suppos'd to contain silver, and who wrought some of them himself at no small charge, yet not without profit, assured me, that the lead-ore which had been wrought, and laid in heaps, did, in tract of time, become impregnated with metal again; and, as experience manifested, proved worth working a second time. And indeed, some mineralists deliver it as a general observation, that the growth and second generation of metals, is more manifest in lead, than in any other of them. *Boccatinus Certardus* delivers it as a thing certainly known of a mountain near *Florence*; that "if the lead-stones it contains be dug up, others in time will grow in their places." And *Agricola* speaking of the growth of mines in general, tells us, that "the passages of them have in a short time been straitned, and grown together by the increase of their matter." But I doubt this increase of lead is not observable in all mines of that metal; because a gentleman, whose house was seated near several lead-mines, and who was himself owner of one or two, assured me, that in the country where he lives, he never observed the lead-ore to increase, either out of the veins, nor in them; and that in some places, where ore had been dug 30 or 40, if not 50 years before, he perceiv'd not on the sides of the passages whence the ore had been taken, that any other had grown in its stead; or that the passages, tho' narrow before, were sensibly straitned, much less block'd up. And, indeed, if there were no other arguments in the case, the straitning of the ancient passages in process of time, wou'd not convince me of the growth of metals; for the soils that abound with them usually also abound with waters, which are commonly imbibed by the neighbouring earth;

The growth  
of lead.

NAT. HIST. earth; and this water is expanded, by being turned into ice; and this expansion is made with an exceeding great force, by which it often stretches, or breaks through the things that contain it; whence 'tis probable, that sometimes the narrowness of the subterranean passages in mines, may proceed from the water imbibed by the surrounding soil, and being frozen in sharp winters: for by this means the soil must forcibly endeavour to expand it self, and actually do so in the parts contiguous to the passage, since there it finds no resistance; and tho' the expansion made in one year or two be but small, and therefore not observ'd, yet in a succession of many winters, it may, by degrees, grow to be very considerable. But Dr. Brown, in his travels, speaking of a mine, has these words: "Some passages in this mine cut thro' the  
 " rock, and long disused, have grown up again; and I observ'd the  
 " sides of some which had been formerly wide enough to carry their  
 " ore thorough, to approach each other; so that we pass'd with diffi-  
 " culty. This happens chiefly in moist places; and the passages unite  
 " not from the top to the bottom, but from the sides." Upon the whole; I take the argument drawn from the increasing straitness of the passages in mines, to make more for the growth of metals, than what is much relied on by some writers, who urge, that in churches, and other magnificent buildings that are leaded over, the metalline roofs, in a long tract of years, greatly increase in weight; so that often there is a necessity to remove them. For having had some occasion to observe and enquire after this kind of lead, I soon suspected, that the increase of weight, which sometimes, indeed, may be very great, was no clear proof of the real growth of the metal it self. In that which I had occasion to consider, the additional weight, as well as bulk, seem'd to proceed from sharp, or other saline corpuscles of the timber of the buildings; which by degrees exhaling and corroding that side of the lead whereon they fastened, turned it with themselves into a kind of ceruse. For, 1. I have found by trial purposely made, that woods afford an acid, tho' not a merely acid liquor, capable of corroding lead. 2. 'Tis known, that lead turned into ceruse, gains considerably in weight; some say six or seven pound in the hundred. 3. From the sheets of lead that have very long cover'd churches, and the like buildings, there is often obtained, by scraping, a large proportion of white lead, which I have known much preferr'd by an eminent artist, to common ceruse, when a white pigment was to be employ'd. And, by the way, men finding this ceruse, not on that side of the lead which is expos'd to the external air, where I scarce ever observed any, but on the inside that lies on the timber, and other wooden work, it may disabuse those who fancy this ceruse to be a part of the lead calcined by the beams of the sun. And if to this be added, that by distillation, and otherwise, I have found cause to suspect, that alabaster and white marble may emit spirituous parts, which will invade lead; it may be doubted, whether what *Galen* relates of the great intumescence of the leaden bands, where-

wherewith the feet of statues were fasten'd to their pedestals, be a sure NAT. HIST.  
argument of the real growth of that metal in the air.

I cou'd not find in one of our chief iron-mines, that there was any *The growth of iron.*  
notice taken of the growth of iron; but in another place or two, some who deal in iron-ore informed me, that they believe it grows, and may be regenerated; and upon that account one of them set up a work contiguous to some land of mine, to melt over again the remainder of ore that had been already wrought at a great distance from that place; and had for some ages lain in heaps expos'd to the free air. But of the growth of iron in the island of *Ilva* in the *Tyrrhene* sea, near the coast of *Tuscany*, not only ancient writers, as *Pliny* and *Strabo*, take particular notice; but modern mineralists of very good credit, as *Fallopins* and *Cassalpinus*. The latter tells us, that "an incredible quantity was there produc'd in his time; and that even the earth which they throw up in digging the vein, after a while becomes a vein it self." *Agricola* gives us the like account of a place in *Germany*; and the learned *Joh. Gerhardus* assures us, he was told by one who dug in the iron-mines near *Amberg*, that "the mere earth there dug up with the ore, being mix'd with the dross of the iron, and thrown in heaps, expos'd to the sun, and the rain, usually in 15 years time afforded, by melting, a thin kind of iron fit only for plates."

In a *French* collection of voyages, published by a person of great curiosity and industry, there is an account given by a gentleman, of a late voyage he made to *Peru*. This gentleman informs us, that the best silver *The growth of silver.*  
in all the *Indies*, and the purest, is that of the mines of *Potosi*; where they draw this metal even from the mineral earths; which were formerly thrown aside, when the ground was opened, and the grooves and shafts in the mountains made; metal having been observ'd to be form'd in them afresh since those times; which sufficiently shews the propensity of the soil to the production of this metal: yet 'tis true, adds he, that these impregnated earths yield not so much as the ordinary ore found in veins betwixt the rocks.

As for the growth of gold, the inquiries I have yet made, among *The growth of gold.*  
travellers, give me no great satisfaction about it; and tho' I have discours'd with several who had been at *Guinea*, *Congo*, and other parts of *Afric*, where much gold is to be had; yet I cou'd not learn, that they, or any acquaintance of theirs among the natives, had seen any mines or veins of gold. And afterwards meeting with a learned traveller, who had carefully visited the famous gold-mine at *Cremnitz* in *Hungary*, he assured me, he cou'd not learn from the miners, whether or no the ore of gold, &c. did really grow, or were regenerated in tract of time, by being expos'd to the air, or upon any other account. But the grand overseer, who was lord of part of the soil, told him, that he thought the whole mountain abounded with particles of gold; and therefore when the diggers had almost exhausted a vein, he there cast in large



NAT.HIST. quantities of earth, and fell to work upon other neighbouring places; whilst that earth being kept there, as in a reservatory, wou'd afterwards afford gold as the mine had done before. And a late *German* professor of physick says, that "at *Corbac*, a city of *Westphalia*, they melt gold out of their heaps of earth once in four years; in which time they find it generated afresh." "The common yellow earth of the country near *Cremnitz*, says *Dr. Brown*, in his travels, especially of the hills towards the west, altho' not esteemed ore, affords some gold. And in one place, I saw a great part of a hill dug away, which had been cast into the works, wash'd and wrought in the same manner, as pounded ore, with considerable profit." I have also some fine gold that never endured the fire, taken out of tin-ore. But whether it be the contact or operation of the air, or some internal disposition, analogous to a metalline seed or ferment, that causes this increase in metals, I dare not be positive; tho' the probable interest of the air herein, will sufficiently excuse my alledging these instances, as favourable to my suspicion, till further experience shall have more clearly instructed us.



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T H E  
O R I G I N and V I R T U E S  
O F  
G E M S.

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S E C T. I.

**I**N proposing my conjectures about the virtues of gems, I shall not suppose the truth of those wonderful properties that some have ascribed to them; tho' not only writers of natural magic, but grave authors, have appeared in their favour. For my part, I never saw any great matters performed by those costly stones, that are usually worn in rings; yet because physicians have, for many ages, received the fragments of precious stones into some of their most celebrated cordial compositions; and because many eminent men, and some virtuosi of my own acquaintance, have informed me of very considerable effects of some gems upon their own particular observations; and lastly, because it is not impossible that some of the softer stones may have considerable operations upon the human body, a few of which I am my self convinc'd of, I dare not indiscriminately reject all the medicinal virtues that tradition, and the writers upon precious stones, have ascribed to them: but suspecting most of their relations to be fabulous, I wholly aim to assign a cause of those virtues ascribed to gems, which experience warrants to be real and true.

Having thus explained in what sense my thoughts as to the virtues of precious stones are to be understood, I come to propose my hypothesis about them; the substance of which may be comprized in these two particulars. First, many gems and medicinal stones, either have once been in a fluid state, or are in part made up of such substances as were formerly fluid. Secondly, many of the real virtues of such stones may probably be derived from the mixture of metalline, and other mine-

*Gems were once fluid, and have their virtues from mineral matter.*

NAT. HIST. ral substances, usually incorporated with them; whilst the great variety and efficacy of those virtues may be owing to some happy concurrent circumstances of that commixture. The former of these heads relates properly to the origin of gems; and the latter, partly to that, and partly to the kinds and degrees of their virtues.

But that any gem<sup>s</sup>, especially the hardest sort, should have a later beginning than the earth it self, will, probably, appear a paradox; and I doubt not it will pass with many for a great one, that some of these hardest of solid bodies, should have once been fluids; but the following considerations will countenance this hypothesis.

*That gems  
were once  
fluid, argued  
from their  
transparency.*

And first, the transparency of diamonds, rubies, sapphires, &c. agrees very well with this conjecture, and thereby seems to favour it; for 'tis not so likely, that bodies which were never fluid, should have their constituent parts set in the order requisite to transparency as those that were once in a liquid form; during which it is easie for the rays of light to make themselves passages every way, and dispose the solid corpuscles after the manner necessary to the constitution of a transparent body. Thus we see, that silver dissolved in *Aqua fortis*, or lead in spirit of vinegar, having thereby had their particles reduced to a fluid state, those particles, tho' before opaque, are so disposed as to make not only a diaphanous solution, but, if desired, transparent crystals; and the experiments that chymists usually make with these metals, I have made with several stones. But this argument is produced rather to confirm, than prove my conjecture.

*Figuration.*

2dly, The origin I assign to gems, may be also countenanced by the external figuration of several of them. For we plainly see, that the corpuscles of nitre, alum, vitriol, and even common salt, being suffered to coagulate in the liquors wherein they floated before, will convene into crystals of curious and determinate shapes. And the like I have tried in several metalline bodies, dissolved in their respective menstrua. But unless a concreting stone, or other like body, be either surrounded with, or in great part contiguous to a fluid, 'tis not easie to conceive how it should acquire a curious, angular, and determinate figure. For concrement bodies, if they have not room enough in an ambient fluid for the most suitable ranging of their parts, cannot cast themselves into such fine and regular shapes as several gems seem to affect; but the matter they consist of, must conform to the figures of the cavity that contains it, which, in this case, has not so much the nature of a womb, as of a mould. Thus we see salt-peter, and several other salts, if the water they were dissolved in be too far exhaled, before they are suffered to shoot, will, if the liquor fill the glass, sometimes coagulate into a mass, fashion'd like the inside of the containing vessel; or if a considerable quantity of liquor remain after the coagulation, that part of the nitre which was reduced to concrete next the glass, will have the shape of the internal surface thereof; but the crystals contiguous to the remaining liquor, having  
a fluid

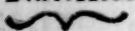


a fluid ambient to shoot in, will have the part of their bodies contiguous to the liquor, curiously form'd into such prismatical shapes as are peculiar to nitre.

To apply this to gems. That many kinds of them have geometrical and determinate shapes, I have often observed, in viewing them as nature produced them; for I have had the good fortune to take several out of their wombs. And upon freeing a large number of *Indian* granats from a lump of heterogeneous matter, whose distinct cavities, like so many cells, contained stones; on some of their surfaces appeared triangles, parallelograms, &c. And from the rock, whence those stones chiefly come, that are commonly called *Bristol* stones, I procured a number of them to be dug up in my presence; many of which appeared to be curiously and determinately figured, much like some crystals of nitre that I have taken pleasure to compare with them. And the like configuration I have, also, observed in many *Cornish* diamonds; and particularly in a fair large one found growing, with many lesser, in *Ireland*. Nor is it only in these softer gems, that this curious figuration may be met with; for I found, among many stones which I took to be rubies, and which are exceeding hard, a considerable number, whose figure, tho' not the same with the *Cornish* and *Irish* stones, were yet fine and geometrical. And the like I have observed even in diamonds themselves; and particularly in a large one that was rough, I perceived the surface to consist of several triangular planes, not exactly flat, but including, as it were, smaller triangles within them; that for the most part meet at a point, and seem to constitute a very obtuse, solid angle. Encourag'd by this, I examined several other rough diamonds, and found most of them to have angular and determinate shapes, not unlike those already mentioned. And having thereupon consulted an expert jeweller, he told me, he generally found them to be shaped like that I shewed him; and added, that such a shape was the mark by which he usually judg'd a stone to be a right diamond, if he had not an opportunity to examine it by the hardness.

And, in favour of the comparison betwixt the coagulation of salt-peter and that of gems; having once made an odd menstruum, wherein I was able to dissolve precious stones, there shot in the liquor pretty large crystals, so transparent and well shap'd, that they might easily have pass'd for those of nitre, but were, nevertheless, insipid. And I have often taken notice in such stones as the *Bristol* diamonds, that tho' the part, which may be look'd upon as the upper, were curiously figur'd with six smooth sides, which, at the top, shaped off so as to make six triangles, that terminated like those of a pyramid in a point; yet that which may be look'd upon as the root, or lower part of the stone, was much less transparent, and of an irregular figure: the reason of which seems to be, that this being the part whereby the stone adhered to its womb, was full'd by the mud-

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 muddiness thereof, and reduced to conform it self to the shape of the contiguous cavity; whilst the upper part of the stone was not only form'd of the clearer portion of the petrescent juice, before the waterish vehicle was exhaled, but had room and opportunity to shoot into the curious figure belonging to its nature. And this is much more conspicuous, where many of these crystals grow in clusters out of one mineral cake or lump. Thus I have seen it in those soft transparent concretions which some of the late mineralists call *Fluores*; and particularly in a very fine mineral lump shew'd me by a great prince. For this mass consisted of two flat parallel cakes, that seem'd compos'd of a dirty kind of crystalline substance, and out of each cake there grew, towards the other, a great number of stones, some of which, by their cohesion, kept the two cakes together; and most of these stones, having each of them a little void space about it, wherein it had room to shoot regularly, were geometrically shap'd and colour'd like a *German* amethyst. And I have my self a pretty large stone, taken up here in *England*, which consists of four parts; the lowermost whereof is a thin broad flake of coarse stone, only adorn'd here and there with very minute glittering particles, as if they were of a metalline nature; over this is spread another thin white opaque bed, which is so inclos'd between the former part and the two others, that, without defacing the stone, I cannot well examine it. The third consists of a heap of minute crystals, exceedingly thick set, which therefore look whitish; having little or no tincture of their own; and this part, like the former, is not much thicker than a barley corn. The fourth and uppermost part, which seems, in great measure, to be the same crystals, that, as they grow higher and spread, acquire a deeper colour, is made up of a large number of amethysts, some paler, and others highly tinged; which are of very different figures and magnitudes, according as they seem to have had convenience to shoot; these, at one end of the stone, lie in a flat bed, scarce exceeding a barley-corn in length, whilst those, at the other end, shoot up to a considerable height into figur'd crystals, some of them as big as the end of my little finger, which were the most deeply colour'd, being also of a great hardness; for I found they would easily cut glass.

I remember, also, that from a famous quarry which stood near a spring, that had a petrescent faculty, I caus'd several solid pieces of rough opaque stone to be broken, in hopes of finding some finer juice therein coagulated into some finer substances; and accordingly I observ'd, that in several places the solid massy stone had cavities in it, all about the sides whereof there grew concretions, which, by their limpidity and curious shape, seem'd to have been some finer petrescent fluid, that by a kind of percolation thro' the substance of the grosser stone, had, at length, arriv'd at those cavities; and upon the evaporation of the superfluous, aqueous parts, or by their being soak'd

up

up by the neighbouring stone, had an opportunity to shoot into these fine crystals; which were so numerous, as quite to overlay the sides of the cavities. And an ancient digger in these quarries told me, he had sometimes met with greater quantities of them; and presented me with a large lump or mass, made up of numerous heaps of soft crystals sticking to one another, but none of them to any part of the rock; so that they seemed to have been hastily coagulated in some cleft or cavity, as it were in a mould; where meeting and mixing, before concretion, with some loose particles of clay, the mass might thereby be discoloured. And our argument drawn from the figuration of transparent stones, may be much strengthened by that coalition I have sometimes observed of two or more such stones; and the congruity in the shape of some of them, to the figures of the contiguous parts of the others, that seemed to have been formed after them.

3dly, The internal texture of these gems also favours our hypothesis; some of them seeming much to imitate, in their coagulation, several of those substances, which I have observ'd were once fluid. 'Tis easily observed, that common salt may consist of small saline particles, which by a convenient juxtaposition are associated into great lumps, several of which have a cubical figure. And that such coalitions of particles may constitute solid and considerably hard bodies, I have tried by breaking some of the larger cubes of sal-gem, and the lumps of *Mayo* salt; whereof the first is fossil, the other marine, and both natural. I have, likewise, found by trial, that tho' silver dissolv'd in *Aqua fortis*, usually appears to shoot into flat, and exceeding thin flakes; yet 'tis very possible so to order the coagulation, that many of these thin plates shall, in their convention, have their flat sides so placed over one another, as to make up pretty large and clear crystals, whose very outsides will be finely figured. And as these are not the only fluid bodies I have brought to coagulate into such a flaky substance, I began to suspect that many transparent minerals may have the like texture; and in some diaphanous kinds of talc, whose outsides were regularly figured, I found encouragement to try, whether even some gems, notwithstanding their hardness, might not have such an internal figuration. I was not deterred from this enquiry by its being generally supposed, that gems are of an uniform texture; and that there must be an immense thinness in the plates which compose transparent stones; since no such thing as plates had been discovered by the most curious eye: and men having allow'd all gems to be uniform in their texture, without any grain or fibres more than there are in gold. But as to this thinness of the plates, I remember I have several times held a piece of good *Muscovy* glass against the light, so thin, that a curious eye cou'd scarce discover the plate it self, which therefore, by no means seemed capable of being split; yet in this case I have sometimes subdivided it beyond expectation. And having carefully examined some stones, that had geometrical figures on part of their surfaces, and which I had reason to think were once fluid

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Internal texture.



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I remember also, that by holding a large, rough, grizollette, that is, a hard gem of a bluish colour, brought from *East-India*, against the light, and curiously observing it, I have sometimes plainly discovered a grain, as they call it, therein; according to the tendency whereof, I have been assured by a skilful artist, who used to make seals of these stones, that they wou'd usually split. I forbear to urge, that in some other precious stones cut and polished, as particularly the hyacinth and sapphire, by turning them several ways to the light, I have observ'd commissures so fine, as not to prejudice the entireness of the stone for the lapidaries purpose; because the phenomenon is far less considerable than what I have often observed in *New-English* granats; wherein, especially when they are broken, the edges and commissures of the thin plates, or flakes, whereof they consisted, are very easily discernable. And to try whether this observation wou'd hold even in the hardest stones, I had recourse to a pretty large, unwrought diamond; which being placed in a microscope, shew'd me the commissures of the flakes I looked for, whose edges were not so exactly dispos'd into a plain, but that some of them stood very sensibly extant, like little ridges, broad at the top, above the level of the rest. And these parallel flakes, with their commissures, I cou'd in a large diamond plainly discern, even with my naked eye. And further, an eminent jeweller, and another artificer, whose trade it was to polish and cut diamonds, assured me, upon their repeated and constant experience, that 'twas almost impossible to split diamonds smoothly, in a direction contrary to their grain; but easily, and at one single stroke, with a steel tool, when once they had found in what line their instrument should be impell'd. By this 'tis evident, that diamonds themselves have a grain, or flaky contexture, not unlike that of wood, which will readily be granted to consist of assimilated water or juices, that having been once fluid, were fit to have their particles so rang'd or dispos'd, as to constitute a body far more easie to be cleft along the direction of its fibres, than in a way contrary thereto. And I remember, that having observed in a rough diamond, which I purposely examined, the flakes whose edges were terminated in one of its plains, to be far from running parallel to those whose edges compos'd another; I imagined, that if this diamond were to be cleft, it wou'd not be smoothly split into two pieces, because the commissures probably made angles in the body of the stone; and accordingly, I learn'd of a diamond-cutter, that he sometimes met with stones, which baffled all his skill, and wou'd by no means split, like others, into two parts; but before they were cleft quite thorough, break in pieces. And this disposition in the stone he cou'd not certainly foresee.

4thly, It seems not improbable, that the colours of some gems are adventitious, and were imparted to them either by some tinging mineral juice or exhalation, whilst the stone was either in *solutis principis*, or of an open texture. And this argument is too considerable to be slightly pass'd over. For in the first place, a multitude of gems have been deprived of their colour, by continuing long in the fire; and the experienced *Boetius de Boot* affirms, that all gems will lose their colour by this means, except *Bohemian granats*. How far this may hold true, I have not had opportunity thoroughly to examine; but I well remember, that having purposely expos'd several gems in a crucible, to a moderate fire, some of them seem'd to have their tincture much impair'd, and others quite destroyed thereby. But if these trials be not warily made, they may easily impose upon us; especially if we do not consider the nature and cause of whiteness: for any diaphanous body, as far as I have yet observed, being divided into a multitude of very minute parts, and consequently acquiring a multitude of distinct surfaces, which briskly reflect the light every way outwards, will appear to have a white colour, more or less vivid, as the particles are more or less numerous, minute, and otherwise fitted to scatter the incident rays. Thus fine *Venice glass* reduced to powder, will be white; and even red ink, if so shaken, as to be brought to a froth, consisting of many minute bubbles, will seem whitish: whence, if by too hasty an ignition or refrigeration of the gems, they come to be flaw'd with innumerable little cracks, they may be thought to become white by having their tincture driven away; when their whiteness really proceeds from the multitude of those little flaws, which are singly unperceived; and this the rather, because the body may still retain its former shape, or seeming entireness. To illustrate this, I have sometimes heated a piece of crystal red hot in a crucible, and then quenched it in cold water; for even when the parts did not fall asunder, but the body retained its former shape, the multitude of little cracks that were by this operation produced in it, made it quite lose its transparency, and appear a white body. In making this experiment, the multitude of the flaws produced may be rendered more visible, if the heated crystal be warily and dexterously quenched in a very deep solution of cochineal, made with spirit of wine; whereby, if the operation be well perform'd, enow of the red particles of the solution will get into the cracks of the crystal, to give it a pleasing colour.

(2.) The colours of several gems, when not destroyed by fire, will be altered thereby; which happening to several fossil pigments, and other bodies, confessedly mineral, argues a mixture of mineral substances in the stones, whose colours receive those alterations; for there may be a change of colour produced by the fire, without any alteration of the tinging parts considered in that capacity. Thus by flaming the heated gem, in very many parts, a degree of whiteness or paleness emerging thereupon, may somewhat change its former colour.

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Their colours  
being probably  
adventitious.

NAT.HIST.  lour: but this alteration being only a kind of dilution, is not that which I here mean. I have, by exposing *Indian* granats, in a crucible, to the fire, found them exchange their reddish colour for a dark and dirty one, like that of iron long kept in the air. And having kept some pieces of agate prettily adorned with waves of different colours, for a competent time in the fire, I found, that the greatest part of the agate seem'd to be depriv'd of its tincture, and reduc'd to a pleasant whiteness. But in some places, where there were stains of a different kind from the rest, and where there run little veins that I suspected to be of a metalline nature, the colour was not destroyed, but changed; and the veins of the pigment acquir'd a deep redness, which they will retain, if let alone; tho' I was induced, by some trials I made on other pieces of *Indian* agate, to think, that even these metalline tinctures might be driven away by a more lasting fire, so as to leave the stones purely white. A like change of colour is, likewise, found in some other stones; as also, in some pebbles, amongst several of which, that lost only their transparency by ignition and extinction in water, one or two acquired a colour remarkably deeper than they had before.

(3.) Having borrowed an *Oculus mundi*, its colour white, figure round and plano-convex, and diameter about a third part of an inch; I put it into a very shallow glass-vessel, almost fill'd with fair water, and observ'd within a minute, that one part of the edge began to appear somewhat transparent; and the whole stone, by degrees, lost its whiteness, appearing of a dark brownish colour. This change had reach'd the whole surface, by lying nine minutes in the water; then taking it out, I perceiv'd the body was grown half transparent, and the parts, near the edge, being less thick, appeared to have lost much more of their former opacity than the innermost part. Then putting the stone presently into the water again, I let it lie there till half an hour was expired from the beginning of the experiment; when, taking it out, and wiping it, I found it was grown much clearer; for being held against the light, it looked almost like yellow amber, but not quite so transparent. I next exposed it to the air, in a very good balance (where it weigh'd four grains and about a quarter) and there left it for near half an hour, to try, if by the recess of any imbib'd aqueous moisture, it would become lighter; but I was hindered from compleating the experiment. Tho' this did not deter me from making another observation, which was, that within about a minute after, I found a portion of the stone, near one part of the edge, grown manifestly opake and whitish; and in a few minutes more the whole stone began to appear in a changing condition, but did not change in every part at once, nor did the alteration make an uniform progress; but one might successively discover several white arches, or as 'twere zones, parallel to each other; and these being quite opake, intercepted between them other little zones, which being yet semi-opake,



appeared of a brown colour, and concurr'd to make the stone look like a pretty agate, wherein the whiteness made a continual progress as long as the time permitted me to observe it: and the possessor assur'd me, that within an hour or two it would be all of a cream white. And indeed I saw one part of it, that was pretty broad, had already obtain'd a whiteness little inferior to that of ivory.

(4.) Another circumstance which seems to favour our conjecture is, that it has been often observed, that where coloured gems are found, some mines or veins of metals are, also, to be met with. And I think it not unlikely, that, upon a skilful search, many more discoveries would be made of veins, either of metalline ore, or some other mineral; whence, by means of juices or fumes, gems may be presum'd to have received their tinctures. But usually where precious stones are found, mens industry and curiosity is too much confined to those rich minerals, and does not permit them to look after inferior ones. And in the *East-Indies*, where most gems are produced in greatest perfection, they are strangely ignorant in the manner of digging mines. To this we may add, that gems are often found in the metalline veins themselves, or very near them; and I can produce several amethysts that a gentleman of my acquaintance took out of a piece of ground abounding with the ores of iron and tin; the latter of which was there dug up in plenty. And in colder countries, such as *Germany* and *England*, where hard gems are more rare, the soft ones that mineralists call *Fluores*, are often to be found in or near metalline veins, so finely tinged by mineral juices, that were it not for their softness, they might pass for emeralds, rubies, sapphires, &c. as I learn from mineral writers of good credit, from eye-witnesses, and partly from my own observation.

(5.) But further to the same purpose, it seems possible to obtain from some gems, by menstrua, tinctures, that seem rather extractions, than proper dissolutions. I once made a menstruum, which being poured upon well-colour'd granats, not calcined, but entire, was thereby soon beautified with a high and lovely tincture, admired by very skilful persons to whom I shewed it, because the menstruum was not more corrosive than white-wine; yet I took this to be a genuine tincture, because it was drawn in the cold, because the liquor would not tinge it self by standing alone; and lastly, because it drew a tincture from antimony of a very different colour from that we speak of. Nor are granats the only gems which I have made this liquor work upon, without heat.

(6.) Suspecting, for several reasons, that some granats contain, besides other metalline substances, many corpuscles of a ferruginous nature, I made choice of some small ones, which by their deep and almost dark colour, I guessed participated largely of iron or steel, and applied them to a vigorous loadstone, which, as I expected, readily took them up; and hereto they constantly adhered till they were forcibly

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(7.) Some gems, which jewellers without scruple, affirm to be rubies, sapphires, &c. are either colourless, or have other colours than those which usually belong to them. The famous goldsmith *Benvenuto Cellini* says, there is one kind of rubies naturally white, which he proves by the degree of hardness peculiar to rubies. And the same author mentions white berils, topazes, and amethysts; and, by his account, the *Italian* jewellers think not the tinctures of gems any thing near so essential to them as we commonly repute; since they reckon topazes and sapphires, whereof one is blue, and the other yellow, but both extremely hard in comparison of all other gems, except diamonds, to be of the same species. The degree of hardness in rubies and sapphires is often so equal, that I knew an expert *English* jeweller, who for that only reason took them to be the same kind of stone.

And that gems, referr'd by lapidaries to the same kind, may be very differently tinged, is a truth whereof I have seen notable instances in diamonds themselves; which I therefore prefer to other examples, because the extreme hardness of diamonds is what keeps jewellers from mistaking any other stone for them; if they may be allow'd to try them on the wheel employed to cut them. Now of true diamonds I have seen some that were yellowish, others more yellow, and among the rest, one that was so perfectly yellow, that I at first took it for a fair topaz, tho' it was valued at near three pound weight of gold. I have also seen rough diamonds, as they came directly out of the *Indies*, which were either bluish or greenish, and one particularly which was so green, that if its shape, &c. had not convinc'd me of the contrary, I should have taken it for an emerald.

I once purchased a considerable number of small rubies, many of which were very curiously shap'd; and coming to look upon the whole parcel more leisurely, I found one colourless, but in other respects so like the rest, that I conjectured it of the same kind, only coagulated and hardened before the mineral pigment had tinged it of the colour of the rest. And I was confirm'd in my guess by a gentleman, who had been in the chief places of the *East-Indies*, where rubies are found, and particularly at the river of *Siam* or *Pegu*, where he frequently saw these stones taken from the bottom of the water, and, sometimes, took them out himself. This gentleman assured me, he had there seen several stones, each of which was partly a ruby and partly colourless; and that, sometimes, in the same stone there would be two portions of one sort, and a third, lying betwixt them, of another; which has frequently oblig'd the jewellers considerably to lessen the bulk of such stone, by cutting off the untinged part. And if my memory does not much deceive me, I saw, in a curious prince's cabinet, a ring set with a stone of a moderate bigness, whereof only about one half was well

well tinged, while the other remained colourless. In gems that are less precious, and not so transparent, especially in agate and opaque stones, I could easily give a multitude of instances of the same entire stone being differently tinged in several parts; and I usually wear, in a ring, a small sardonix, wherein there are three portions, one within another; the uppermost whereof is black, the middle a kind of chestnut colour, the other blue, almost like a turquoise; each of which portions is exactly of a fine oval figure, and each of the two outermost of a very uniform breadth and colour throughout, and exactly parallel to the other. And to instance in transparent stones, 'tis known, that jewellers reckon, among sapphires, not only that sort of azure stones which usually pass under that name, but also another kind, because of their sapphirine hardness; tho' for their want of tincture they call them white sapphires.

(8.) We sometimes see gems partly tinged, and partly not, in such a manner as if the pigment, mixing with one portion of the matter, whereof the stone consisted whilst it was liquid or soft, were not able to diffuse it self thro' the whole, nor to give an equally intense colour to all the portions it tinges. 'Tis true, in some cases the diffusion may be stopped by the petrescent juices first coagulating in a part where the tincture was not mixed; and perhaps in others, the different colours may have belong'd to different portions of matter coagulating upon or against each other, at different times, yet so as to seem one entire stone; but which soever of these explications be admitted, it will confirm our hypothesis, that the origin of gems is from a fluid or soft material. I have in some hard semi-dia-phanous stones, as well *European* as *East-Indian*, observed a very irregular and unequal diffusion of tincture. And in *Italy*, I have seen a large piece of crystal, whereof the pyramidal part was of a transparent green, whilst the vertex appeared richly tinged like an emerald; but the farther the colour spread from thence, the fainter and paler it grew; so that before it came near the base, it was quite spent, and left the larger part of the stone transparent and colourless, like ordinary crystal. And hence, perhaps, we may explain the meaning of *Josephus Acosta*, where he says, that emeralds grow in stones like crystal; that he had seen them in the same stone fashion'd like a vein; and that they seem, gradually to thicken and refine. And this learned author has a memorable observation, that may confirm both what I have just now related, and what we mentioned a little above about colourless gems: "I have seen, says he, some that were half white and half green; others all white, some green, and very perfect."

To conclude, I have given to pieces of rock-crystal, tolerably good tinctures by mineral fumes; and supposing the pieces, thus coloured, to be entire stones, as they generally appeared to be, the instance will be pertinent to our purpose; for tho' the colours thus given, do not usually penetrate very deep, and are assisted by no faint degree of



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*Heterogeneous matter having been found in their substance.*

5 *thly*, Solid gems may include heterogeneous matter in them. Several instances of this sort I have seen in opaque stones; but in transparent ones they are very great rarities; and therefore it will not, I presume, be thought strange, if I mention but a few. First then, a very ingenious lady, who had accompanied her husband in an embassy to a great monarch, assured me, that she brought back with her a piece of crystal, in the middle whereof there was a drop of water, that by its motion might be very easily observed; especially when the crystal was made to change its posture; and I have in some pieces of rock-crystal observ'd particulars, which seemed to argue, that somewhat or other was intercepted in the body of the stone.

A curious person who traded in *Indian* gems, particularly in grizolets, averr'd to me, that among several rough ones brought from the *Indies*, he had seen one that was about the bigness of a filberd; in the solid substance whereof there was a cavity, with a certain liquor in it, which, by changing the posture of the stone, might be made to move to and fro. And when the drop was settled, it was of the bigness of a round pearl, that he shewed me, which wanted somewhat of a moderate size for a necklace; he added, that this rarity caused the stone, which was otherwise of small value, to be priz'd at an hundred pounds. And I have my self seen a monstrous gem, which was little less a rarity than the former. And what renders this account of the grizolet the more probable, having broken a stone, that was brought as a rarity from the *East-Indies*, where gems are often harbour'd in such stones, I found in the solid substance of it, which was so hard as to strike fire like a flint, and in its little flakes was at least semi-diaphanous, a cavity, wherein were coagulated very minute, polished, crystalline stones, that seemed to have their points inwards; which argued there had been some liquor there, wherein these glittering particles had shot, tho' in process of time, the remaining and incoagulable part  
of

of it might have been imbibed by the ambient matter, if not have escaped thorough it, by virtue of some peculiar congruity of it with the pores of the stone; which need not be thought impossible, since experience has assured us, that some solid stones, and even gems, may be penetrated, or have their texture altered by common water. Nor are these the only heterogeneous substances I found included in this stone.

Amber, which is reckon'd among gems, and sometimes proves exceeding hard, affords a great confirmation, or at least an illustration of what I have been saying; for I have now by me a fine piece of that substance clear and solid, wherein is included a large entire fly, in shape and size much like a grasshopper, but variously and curiously colour'd, with his wings display'd.

To these observations I shall add, that I have possess'd one of those pale amethysts, which some call white, wherewith I cou'd readily cut glass; yet in the body of this stone there appeared to be a considerable number of things that look'd exactly like hairs, some of them lying parallel, and others inclining to one another; and upon viewing them, both by the light of the sun, and that of a candle, in various positions, some of them seem'd at times to be of a lovely reddish colour, but reflect'd the light, as if they were well fill'd either with air or water; tho' for the most part they seem'd of a brownish colour, which made the stone not a little admir'd. And a gentleman, eminent for his travels into the *Eastern* parts, and for his skill in jewels, told me, that he had seen a white sapphire, a table-stone, about the middle whereof appeared a cavity, large as a pin's head, or a small vetch, containing a drop of liquor, that it seems cou'd not be coagulated into stone with the rest of the matter. This liquor, he said, was very easily discernible, by shifting its place in the cavity, as the stone was put into different postures. He farther assured me, there was no flaw in the stone, at which the liquor might be suspected to have entered, but that the cavity appeared every way encompass'd by the solid stone, and lay about the thickness of three barley-corns, below the upper surface of it. And, indeed, I have sometimes suspected, that even in diamonds themselves there may possibly be intercepted, or mixed with the pure petrescent substance, particles of heterogeneous matter; and in this suspicion I was a little confirm'd, by the odd clouds I had observ'd in an extraordinary diamond, and by hydrostatical, and other observations, made upon such stones; some of which prov'd heavier than either crystal, or white marble. And, likewise, an ancient diamond-cutter of great experience assured me, he had observ'd a sensible difference of weight among diamonds of the same growth, especially in those that were cloudy or foul; and that he sometimes found in diamonds of the bigness of two peas, it amounted to about a carret, which is by common estimation four grains.

6thly, The last argument I shall produce to shew, that the matter of several gems may have been once fluid, arises from the proofs of the  
second

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And metalline, or mineral bodies mixed with their smallest particles.

second part of our hypothesis; for if it shall appear, that many transparent gems have metalline, or other extraneous mineral bodies, intimately mingled with their smallest particles, it will be very reasonable to suppose, that such a mixture was made, when the bodies were in a fluid form; how else should the metalline corpuscles be convey'd into such compact and hard bodies as gems? But if our hypothesis be admitted, 'tis easie to apprehend how among bodies so entirely different as metals and stones, such exquisite mixtures may be made, as are required to give an uniform colour, transparency, and figure to them.

To strengthen the preceding circumstances, I shall add the testimony of a late *French* author, who wrote about the method of estimating gems, according to the rates of modern jewellers. This curious gentleman gives us, from the mouth of the late famous travellers he conversed with in several parts, an account of the number and names of the places where diamonds and rubies are found in the *Indies*; adding some circumstances and particularities about the quality of the soil in those places, that I have not elsewhere met with. Speaking of the first of those three diamond mines, which he takes to be the only ones in the *East-Indies*, after having told us, that the stones are there found some in the ground, and some in the rock, he adds, that those drawn from the rock, or the neighbouring parts, have commonly a good water; but for those which are drawn out of the ground, their water partakes of the colour or soil wherein they are found; so that if the earth be clean, and somewhat sandy, the diamonds will be of a good water; but if fat, black, &c. they will have some tincture thereof: nay, he immediately annexes, that if there be some black or red sand among the earth, the diamond will also retain some grain of it. And mentioning the second mine of diamonds, he declares, that here, as in the former, the stones partake of the quality of the soil; so that if that be boggy or moist, the stone will incline to blackness; and if reddish, 'twill have an eye of that colour. He also tells us, that of late there were found in the kingdom of *Golconda*, store of diamonds; which being brought to the first minister of state, he forbid all further search after them, because not one in the whole number had a good water; the whole parcel being either black or yellow.

Whether gems are fashioned by some seminal or plastic power?

Before we proceed further, 'tis proper in this place to take notice of a considerable objection that may be offer'd, against the doctrine hitherto deliver'd. This objection is taken from the configuration of some gems, and especially the prismatical one of crystal, whereof we have given several instances. For it seems scarce possible, that so curious a shape shou'd be so uniformly produced, in such a multitude of crystals, great and small, unless there were some seminal and plastic power to fashion their matter in a regular and geometrical manner.

But he who shall attentively consider the figuration of salts, and of metalline and other magisteries dissolved and coagulated with them, may be thereby greatly assisted to discover the invalidity of this ob-



objection; but because 'tis very specious and important, I shall examine it a little more particularly.

And first, there is no absurdity to suppose, that if there be a seminal and plastic power in mineral bodies, it may be harbour'd in liquid principles as well as others; for we see that the seed of animals, which often, as in the elephant, the rhinoceros, &c. produces hard solid bones, teeth, and horns, is at first but a liquid substance; and the forming power in some trees and their fruits, converts the alimental juice into wood, shells, and other very solid, and ponderous bodies.

Secondly, in accounting for the figures of alum, vitriol, and other salts, that are curiously and geometrically shaped, there is no necessity to introduce a distinct, architectonic principle; since those bodies may receive their shapes from the coalition of such singly invisible corpuscles, as by the motion of the fluid, wherein they floated, and other assistant circumstances, are determined to stick together, rather in that manner than another. Thus a salt made from common salt, by the single assistance of oil of sulphur, or of vitriol and water, tho' manifestly a factitious body, wherein the sea-salt has its own nature destroyed, yet by reason of the figure of the resulting corpuscles, and their fitness to convene, when dissolved in water, into curiously shap'd bodies, will, when rightly prepared, often shoot into long crystals, with points like diamonds, resembling native crystal as well in regularity of shape, as transparency of substance. And that 'twas partly the figure produced by the operation of the oil of vitriol upon the sea-salt, and partly other circumstances, that determined the shape of the crystals, appears from hence, that when the quality or proportion of the oil of vitriol, was different from what it should have been, or any error was committed in some part of the operation, the saline concretions, tho' they did not shoot at all like cubes, as the sea-salt, which they were made of, wou'd alone have done; yet they shot very unlike rock-crystal, tho' into crystals for the most part very finely and differently figured. And that the natural figure of the sea-salt is no way necessary to such configurations, is manifest from this experiment. I took some stony *Stiria*, found in caves and grotto's, whose petrescent liquors coagulate, before they have time to fall down; and having dissolved them in spirit of verdigrease, I put the clear solution to evaporate in a digestive furnace, after the ordinary manner; by which means, tho' I made the experiment more than once, I had rather a coagulated mass, than any thing like crystals; whence it appears, that a conjunction of several circumstances may be requisite to determine the figuration of consistent bodies made out of fluids; since here, for want of time to make occurrences enow for the particles to concrete after the most convenient manner, the experiment succeeded not. Upon allowing many days to another solution of the *Sitria*, made in the same menstruum, there shot about the sides and bottom of the

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Perhaps 'twill be said, that the petrescent juice, when broken, often appears to abound on the inside with narrow streaks like those of antimony; and that I my self have observed some gems to be made up of thin plates; which internal figuration seems much more difficult to be accounted for, without a plastic form, than the external.

But, for ought I find, many known salts wou'd, when broken, appear to be geometrically figured, even in their lesser corpuscles, as well as in their entire bulk; if we had eyes sharp enough to discern the shapes of the minute, as well as of the larger bodies. And we have great inducement to think, that the small visible concretions, of which the bigger grains of salt consist, are as well as the greater, of a cubical figure. Besides, there are several bodies so luckily shap'd, that upon a slow coalition, they will convene into a multitude of manifest concretions; some of which consist of streaks, and some of flakes. Thus in the common sal-armoniac, tho' confessedly a factitious body, upon breaking the bigger masses, great multitudes of streaks are observable, like those we usually find in the broken *Stiria* of petrifying water. And I have prepared concretions, some of which consisted of salts alone, and others of salts and minerals, such as stones or antimony, which look'd very like talc, being white bodies made up of a multitude of very slender streaky particles, lying lengthwise one upon another. And as I have taken out of the earth many concretions, outwardly shap'd like a rhombus, and compos'd of a multitude of flat and extremely thin plates; so have I sometimes imitated such concretions by art. And tho' a solution of silver in purified *Aqua fortis*, usually affords only a great company of small, thin, and seemingly simple flakes, like scales of fish; yet having dissolv'd a large quantity of the metal together, and suffer'd it to shoot leisurely, and with due circumstances, I obtained many crystals, which were geometrically figured without; and consisted of a multitude of exceeding thin flakes, orderly adhering to one another. And for a yet more pregnant experiment, to clear this objection; tin-glass, tho' a compact and ponderous body, consists of many shining, polish'd flakes; yet, I found, that if this mineral were melted, and suffer'd to cool of it self, the disposition of its component particles wou'd determine them to stick to one another in broad shining flakes; whereof many will lie upon the rest, and some across each other, at various angles, according as the matter happen'd in its several portions to be refrigerated. There are factitious bodies also, which afford us the like instances; as I have observed in mixtures of copper, iron, and other minerals; and very conspicuously in good *Regulus martis stellatus*, whose internal parts may be found, by breaking it, to consist of flat, shining, polish'd flakes.

If it be urg'd, to strengthen the foregoing objection, that some petrescent juices concrete, even whilst men are looking on; and yet our

stony

stony *Stiria* have in some places a streaky, and in others an angular configuration of parts; I answer first, that I have seen several concretions of that kind, which, as far as appear'd to the eye, were made up of parts confusedly jumbled together. And, secondly, I have found by trials, that if there be a due disposition in the component corpuscles of bodies to such configurations, they may be brought to concrete accordingly, in a far shorter time than one wou'd imagine. Having sometimes warm'd six or seven ounces of *Aqua fortis*, glutted with fine silver, till the mixture was wholly brought into a transparent liquor; and then put the clear, strong glass which contain'd it into cold water, that the menstruum might be the more hastily refrigerated; I observed, that when once the dissolv'd metal began to shoot, the coagulation into figur'd crystals proceeded so fast, that the naked eye cou'd see its progress. And having sometimes put a quantity of salt and snow, or some other strongly refrigerating mixture, into a convenient glass, and wetted the outside with a strong solution of sal-armoniac, or some urinous spirit, whereby, tho' it wou'd be coagulated in less than a minute; yet the salt into which it shot had usually a curious and determinate figure, according to the nature of the liquor that afforded it; as I have often experienced.

Perhaps you will say, these instances are taken from saline bodies, which are, for the most part, disposed to convene into smooth surfaces, and angular shapes, and to be easily wrought on by the external cold; and that it may yet seem strange, what in some cases must have happened, if our hypothesis be admitted, that external circumstances and accidents, such as the figure of a mould, or womb, the coldness of the ambient medium &c. should visibly, and sometimes greatly diversify even the internal figuration of close and solid minerals and gems; without excluding all those that are supposed to be of a quicker concretion.

To clear this difficulty, I shall subjoin an experiment, devised to shew, that if the corpuscles of a body be so shap'd, as to be fitted, by their coalition, to constitute smooth, glossy planes, tho' they be variously shuffled and discomposed as to their pristine order; yet if kept for a while in a state of fluidity, they will presently convene again into smooth, shining planes; and the situation of those planes, with respect to one another, will be exceeding uniform and regular, considering the concretion is hastily made; while their internal texture will be much diversify'd by circumstances, as particularly, by the figure of the vessel or mould, wherein the fluid matter concretes. Considering then, that if, as was lately observed, we break the lumps of tin-glass, it will discover a great many bright and smooth planes, which sometimes meet, and sometimes cross one another, at very different angles; I thought it probable, that a body which had been melted, and was apt to convene into such planes, wou'd not only do the same upon a second fusion, but might have the order and magnitude of these planes



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diversified by the figure and capacity of the vessel, chosen for the purpose. Having, therefore, powder'd a sufficient quantity of tin-glass, when 'twas well melted, and cast it into a good pair of iron moulds, whose cavity was an inch in diameter, we thence obtained a bullet, which, being warily broken, seem'd, as we expected, to be made up of a multitude of little shining planes, so shap'd and placed, that they appeared orderly to decrease, as they were further removed from the superficies of the globe; they were, likewise, so rang'd as to seem made up of a multitude of these rows of planes, reaching every way, almost like so many *radij* of a sphere, from the center to the circumference. But if tin-glass be melted in a crucible, and suffer'd to cool there, the matter, when taken out and broken, will appear, indeed, full of smooth planes, but, as was lately intimated, very irregularly and confusedly associated or ranged.

This experiment we have, also, varied by casting bullets of some other bodies, and particularly of the simple regulus of antimony, and with success; tho' the texture hereby produced was not so uniform as in tin-glass. And by casting melted sulphur into a spherical body of about five or six inches diameter, and breaking it warily; tho' one wou'd think this an unlikely mineral to make any other than a confused concretion; it presented us great fibres almost like little straws; whose number and orderly situation afforded a considerable instance for my present purpose.

And having broken several marcasites of a peculiar sort, that were either roundish or almost of a cylindrical figure, to observe their internal structure and qualifications; I found in some of them a great many rows of little planes, or glittering corpuscles, reaching from the innermost parts to the external surface, and in those that were cylindrical, to the outside. These ranks of gold colour'd particles, in the several planes of the broken mineral, seem'd like semi-diameters, issuing from a row of physical points of an imaginary line, lying almost like the axis of a cylinder; as if the cavities of the chalk or clay, where these marcasites were found, had made the soil like a mould, wherein the matter of them being detained, whilst 'twas in a fluid form, afterwards concreted like the bullets of our tin-glass, &c.

As to the uniformity of shape admir'd in gems, and which is thought to demonstrate them to be form'd by a seminal and geometrical principle; I cannot find, upon a more attentive survey, that it is near so great as men usually imagine.

In several transparent gems it manifestly appears, as I lately noted, that the shape was, in a great measure, owing to the figure of the womb or mould, wherein the matter, whilst liquid or soft, happened to settle. But in some other transparent and well figured gems, of the same denomination, and, sometimes, growing very near one another, I have found, by a diligent inspection, a manifest, and sometimes a very considerable difference of shape, either as to the number, figures,

gures, or bigness of the sides that made it; by comparing these particulars with those of a stone of the same kind perfectly figured. This I took notice of particularly, in two sorts of stones, granats, and *Cornish* diamonds. A considerable number of the former, that grew in *America*, was brought to me in one lump of matter; but growing in distinct parts of it, and without touching one another. Among these I took notice of a manifest disparity of shape; so I did in some *African* ones, as also in others that were *European*; one of which, being of an extraordinary large size for a figured gem of the transparent kind, and weighing above eleven drams and a half, I consider'd, with a particular attention; and found, that tho' it seem'd to have been coagulated in a fluid medium, and to consist of twelve planes, at the concurrence of two or three whereof it seem'd to have been broken off from the root; yet it was very far from the geometrical dodecahedron; for as this consists of twelve equilateral and equiangled pentagons, almost all the planes of our granats were quadrilateral, and very different from what they should regularly have been, not only in magnitude, but in shape; for one of them seem'd to have five sides; and for the rest, some were nearest to a rhombus, others to a rhomboides; but the most were trepezia. And, by the way, a curious person shew'd me a pearl very irregularly shaped, and of an enormous size. It was so artificially set in gold, that by the help of a little of that metal, fitly placed, the whole jewel represented a lion; yet I made a shift to measure it exactly with collapar compasses, and found the length to be an inch and a half, and the greatest breadth, where it was of a proportionable thickness, to be  $\frac{4}{5}$  inch. The colour was orient enough, except one dark spot, which by its size, figure, and situation, I guess'd to be the remains of that part whereby 'twas fasten'd to the shell of the fish which produced it. And thus much for the first sort of gems, whose figures I observ'd to be irregular.

The second consists of those crystalline stones, some of which are much harder than the *Bristol* diamonds, or, perhaps, than rock-crystal itself; for 'tis easie to write upon glass with them. Having procured a large number of these stones, I took notice, by comparing them together, that tho' some of them were geometrically and curiously shap'd like rock-crystal, having each six sides, whereof two, that were opposite, seem'd perfectly alike and equal; and tho' the stone had a pyramidal termination, made up by several resembling and curiously figur'd planes, that ended in a solid angle; yet the greatest number, by much, of these diamonds, consisted of stones whose figures were far from exact and uniform. For tho' most of them had six long planes, yet often the opposite ones were neither parallel to one another, nor similar, but exceedingly unequal; and those planes that went to make up the apex, compar'd with one another, or with regular patterns, their figures, magnitudes, and manner of concurring, were so remote from uniform, as to agree far better with our hypothesis than with the

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the other. And yet the want of room to coagulate freely, could not, with probability, be here pretended; for they seem'd to have been form'd separately in a fluid ambient, except at the bottom, where they were fastened to the rock; as appeared by an opaque root which still adhered to most of them. And, if I misremember not, I have more than once, on diamonds newly brought from the *Indies*, and some of them very fair ones, observed great irregularities in the area's of the superficial planes, or in their figures, or both; and, sometimes, in the very number as well as situation of their solid angles.

I now proceed to shew, that the figuration of gems not only consists with our conjectures, but confirms them; for I have, more than once, taken notice in *Cornish* diamonds, that a small stone, of the same kind, has made, as it were, one body with a greater; not only adhering closely to it, but being bedded in it; so that when they were separated, there remained a cavity in the larger, whose figure exactly answered that of as much of the smaller stone as chanc'd to be lodg'd therein. Thus, also, I have seen a greater grow to a much less; there being a cavity in the latter answerable to the part of the greater that had enter'd it; which seems to shew, that the stone to which the other grew, was first form'd and hardened, since it retain'd its own shape; and that whilst this adhered to the rock or soil, more liquor began to coagulate, by fastening it self to the solid body, which was already concreted. Thus by putting into a strong solution of pure nitre, or rock-alum, some little sticks of wood or other solid body, that may be kept steadily in the same posture, you will see many coagulations begin to be made against them; and the crystals, thus concreted, will necessarily have their figures incompleat, and cavities correspondent to those parts of the stick whereto the saline corpuscles fastened. And tho' I instance this inosculation of figured stones but in *Cornish* diamonds, yet those are not the only transparent minerals wherein I have observed it. And particularly, I found among a parcel of minerals, a fine transparent and neatly figured stone, which seem'd to be pure crystal; but lay coagulated about a kind of branching wire, whereof a great part was enclosed by the stone, seem'd to grow out of a piece of ore, resembling that of silver; which the owner affirmed to be, together with the above mentioned branch, good silver, produced by nature in that form; which excellently agrees with the resemblance I just propos'd, betwixt the coagulation of dissolved salts and the liquid matter of gems, about stable bodies immersed therein.

But to proceed. The second grand consideration, whereon our hypothesis is founded, arises from the weight of some gems, which, being greater than what seems to belong to them, as hard transparent stones, we may, probably, derive it from metalline or mineral mixtures. Gems are estimated by lapidaries as they weigh a determinate number of carrats, or of grains; for they compare only the weight of stones, of the same kind, to one another, as the greater or lesser weight argues a greater or less bulk;

*A greater specific gravity in gems argues their metalline or mineral nature.*



bulk; without regarding the specific gravity of them, which depends not on their magnitude. NAT. HIST.

Now rock-crystal, as it is by mineralists reckon'd among gems, so it is hard enough, as I have tried, both to cut glass and to strike fire; and its having so great a transparency, and wanting colour, makes it exceeding likely to be free from adventitious mixtures. I therefore pitched upon it as the standard whereby to make a probable estimate of the weight of gems; and having hydrostatically examined it, first in the air, and then in water, I found its weight to an equal bulk of the latter fluid, as two and almost two thirds to one; which, by the way, shews us how groundlessly many learned men suppose crystal to be ice extraordinarily hardened by a long and vehement cold; for ice is bulk for bulk, lighter than water; and *Madagascar*, as well as other countries in the torrid zone, abounds with crystal.

Having thus found the weight of crystal to water, when I met with a coloured gem, whose specific gravity I guessed to be sensibly greater than of that, I sometimes weighed them in the air, and in the water, and so discovered whether I had conjectured right. And if the specific gravity of the gem much exceeded that of crystal, I thought it probable there might be some metalline or mineral corpuscles mingled with the stony ones thereof, whence it might also, probably, derive its tincture. Finding some *American* granats, which I had a great and peculiar reason to believe had once been liquid, of a colour so deep, that they were almost opake; and judging, likewise, by my hand, that they were much heavier than pieces of crystal, of the same bulk, I weigh'd them in a pair of nice scales in air, and in water, and found, as I expected, that they were almost four times specifically heavier than that fluid; and, consequently, heavier by about a third part, than pieces of crystal of the same bigness. But we must observe, tho' when colour'd gems have a greater gravity than crystal, 'tis probable some metalline pigment, or other mineral substance, may be mixed with them; yet if such gems have no such additional weight, it will not follow, that their colour cannot proceed from any mineral tincture; since a mineral substance may be present in a liquor even when it adds no manifest weight thereto. Thus I have found a mineral water, which, by its taste, its effects, and the colour it would strike, appeared to be richly impregnated with iron; yet being carefully examined hydrostatically, it seem'd very little, if at all heavier than common water.

The last argument I shall now make use of is, that out of several medicinal stones, and even out of some fine gems, real and corporeal metals, or other mineral substances, may be extracted. But as the further prosecution of this argument will be more proper hereafter, with regard to opake gems, where its force will best appear; I shall but lightly touch upon it in this place. To shew, however, that it affects gems as well as opake stones, I observe first, that several stones reckoned amongst precious ones, are opake; as the turquoise, the onyx,

Metals and minerals may be extracted from gems.

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the sardonix, &c. not to mention the semi-opake. Besides, I much question, whether transparency be absolutely essential to those precious stones, wherein 'tis usually found. And I might here make it probable, that opacity and transparency often depend upon the manner wherein the pigment is dispersed thro' the stony matter of the gem; and the convenient or inconvenient situation of the pores, with respect to the rays of light. Moreover, several precious stones, and even diamonds themselves, have sometimes great clouds, which render them in those parts opake, without hindering them from being true diamonds or gems, of this or that kind, to which their hardness, colour, &c. entitles them; and not to observe that cornelians, agates, and some other stones, are sometimes found to be transparent, and sometimes semi-diaphanous, I have seen even a sardonix transparent. And as for granats, I have had some figured ones that seemed quite opake; and others of several countries, that were in some places diaphanous, but as to the main bulk of their bodies almost as dark as ordinary stones.

And there is no doubt, that the experiments, whereby I have obtained mineral or metalline substances from load-stones, native cinnabar, blood-stones, &c. might also succeed in several of the more ponderous gems; if their glassy nature, or the exceeding compactness of many of them, rendered not the mineral corpuscles harbour'd in the stony, or insoluble parts, inaccessible to the common menstrua. And when the metalline and mineral ingredient is in great plenty, and the tincture of the stony parts not very close; I question not but even from transparent gems, the adventitious ingredient may in part be dissolved: for having by the weight of the granats lately mentioned, concluded them impregnated with somewhat metalline; I kept some of them in a crucible for a competent time in the fire, and found they thereby exchanged their colour for one not unlike that of rough iron. And having reduced them to a very fine powder, and digested some acid menstrua, and particularly rectified spirit of salt upon them, they afforded me a rich tincture. Encouraged by this, I hoped, that without being previously burnt, they wou'd in *Aqua regia* afford a tincture; and accordingly I obtain'd from crude granats, (reduced to very fine powder) a rich solution, which tho' in colour it somewhat resembled a solution of gold; yet partly by the colour of the burnt granats, and partly by the tast of this solution, I supposed that another metal was more likely than gold, to be predominant therein. And having gently evaporated part of that menstruum, I obtained from some of the remainder certain crystals, whose shape, by reason of their smallness and disorderly coagulation, I cou'd not well determine; but, touching the uncoagulated portion of the liquor with the tip of my finger, and adding that part of a drop which rested thereon, to a great many drops of the infusion of galls, it instantaneously turn'd them full as black as ink.

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This trial I made to examine, whether one mineral, at least, that helped to constitute these granats, was not of a feruginous nature; for if it were, I supposed, like other bodies that participate of iron, it would afford, with galls, an inky colour. A parcel, also, of small red transparent stones, guessed by some to be granats, but by others, more probably, rubies, being finely powdered, gave, in an appropriated menstruum, a colour like that of dissolv'd gold; and that some parts of the gems were really dissolv'd in the menstruum, appear'd not only by the colour; but having put some of this liquor to a tincture of galls, it produced, at the very first, a dark colour, tho' not near so black as that of the former granats; and immediately let fall a copious precipitate, that was almost white. I, moreover, precipitated from it, by an urinous spirit, a reddish substance; which being suffer'd to dry in the air, seem'd to grow into bodies shap'd like moss; and here and there small mushrooms, all of them prettily coloured. And from certain granats that were in some places opaque, as well as in others diaphanous, I obtained a solution; the superfluous liquor whereof being abstracted, the residue, which was deeply coloured, did, in the cold, afford a kind of saline concretions; tho' not large enough to have their figures determined.

And, perhaps, if men had the curiosity to make trials, there wou'd be other transparent minerals found, capable to be wrought on by appropriated menstrua. For I do not think that every seeming glassy contexture of a mineral, unfits it for that purpose. Tho' the clear spar, which, in most of our western lead-mines in *England*, is found next to the metalline veins, be at least semi-diaphanous, and of so glassy a texture, that it usually breaks into smooth and glossy superficies, appearing like a talc; and is, also, for the most part made up of geometrically figured bodies, resembling in their surfaces, a rhombus, or rhomboides; yet some other experiments I had made with it, inducing me to suspect, that 'twas not indeed a talc, but a body of a much more open texture, I found I cou'd dissolve it in several liquors; and particularly in good spirit of salt, which wou'd presently work upon it, even whilst it remained in lumps; and that too without the assistance of heat.

But from what I have said as to the usefulness of menstrua, it must not be inferr'd, that they are the only instruments wherewith something metalline may be obtained from gems; for I have made considerable attempts of this kind by fusions, and appropriated additions. And, however such trials may succeed, as to the separating from a gem, a metalline or mineral body of a determinate species, I have an easie way, in which, by the help of fusion, I more than once manifested, in general, that there may be substances partaking of a metalline nature, in some kinds even of transparent gems; and partly by the same method, and partly by others, I have in some cases determined, with probability, that mineral substance is here predominant.



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It may serve to illustrate our hypothesis, that having reduced to powder some *Stiria* of water, spontaneously petrified, dissolved it in spirit of verdigrease, suffered some of it to evaporate, and put the rest into a cool place; I obtained many small, finely figured, and transparent crystals, that shot much after the fashion of those of the purer sort of nitre. With some part, also, of this stony solution, I mixed, in a convenient proportion, a high-coloured solution of copper, made with the same spirit of verdigrease; and the two solutions being warily put together, did not precipitate one another, but afforded, upon the evaporation of their superfluous moisture, among many crystals, that were transparent and colourless, some that were richly adorned with a greenish blue tincture of the dissolved metal.

## S E C T. II.

I Now proceed to those considerations, which, assisted by what has already been delivered, may suffice to shew our conjecture, as to the cause of the virtues of gems, to be rational.

Mineral productions exceeding numerous in the bowels of the earth.

My first observation is, that the earth not only contains a great number and variety of minerals, known by particular names, but very many others wherewith we are hitherto unacquainted. What a vast multitude of metalline ores, marcasites of several sorts, antimonies, tin-glafs, *Fluores*, talcs of various kinds, spars, sulphurs, salts, bitumens, &c. are mentioned by chymists and mineralists, in the accounts of repositories, and collections of natural rarities? Nay, the diligence of some modern writers hath reckoned up between two hundred, and two hundred and fifty fossils of the same kind.

The second part of our observation appears, from considering the very small proportion that the perpendicular depth of the generality of mines, bears to the semi-diameter of the earth; so that tho' our globe were inhabited by some hundred millions of men more than now it is, and they had the curiosity to dig mines every where, their spades wou'd usually penetrate so little a way into the earth, that a vast multitude of fossils might, by lying deeper in the bowels of it, still continue undiscover'd. And, as far as I have observ'd, almost every region hath peculiar minerals, different from those of other countries. Thus in some counties of *England*, a curious eye may, doubtless, observe several, that are unobserved by the inhabitants themselves; especially if well contriv'd borers were diligently and skilfully employed to pierce the ground, and bring up samples of the various fossils that lie hid under it. And this I can my self say, in general, that in some parts of *England*, where I had more opportunity than in others, to exercise my curiosity about minerals; I have, in a small com-

compass of ground met with a much greater variety of them than I expected; many of which were described by no writer that I know of: and several of the like have been sent me from different foreign countries.

In the next place it is to be considered, that nature has furnished the earth with menstua, and other liquors of several sorts, endowed with different qualities; and water being abundantly to be met with under ground, and for the most part very plentifully in mines, it is capable of being variously impregnated; and when thus altered, may, in some cases, act the part of no despicable menstruum; and on other occasions concur to the production of mineral bodies.

*Various men-  
stua in the  
earth.*

I further observe, that the subterraneous liquors, upon one account or other, are qualified to act either as corrosive menstua, or as other solvents, upon many of the medicinal earths and minerals they meet with under ground; which having never been expos'd to our fires, preserve their texture more open, and their parts more soluble, than those that have been melted by the violent heat of a furnace.

And that even common water will suffice to dissolve, and impregnate it self, both with the saline and metalline parts that it meets with in its passage, appears from the different tastes, and other qualities of liquors, which all pass for common water; some whereof are found better than others, for brewing, washing, dying, tempering steel, &c.

But more eminent instances are afforded us by the mineral springs, whether *Therma* or *Acidula*, great numbers whereof are enumerated by physicians and geographers; and many more wou'd, doubtless, be discovered, if men wanted neither skill nor diligence. And tho' common water does the most readily dissolve the salts, properly so call'd, it finds in the bowels of the earth; as we see happens in those salt springs that come not from the sea; yet there are many other subterranean bodies, which, abounding with saline particles, will be dissolved by water, tho' they prove of a compound nature, and contain very different substances; as is plain from those waters of *Hungary*, and other regions, that, by evaporation, yield vitriol, which contains a saline, a sulphureous, a metalline, and an earthy part; every one of which may be made distinctly to appear.

Lastly, the petrifying juice or spirit, coming in a sufficient proportion to be mixed with these impregnated waters, so as to coagulate them, and unite therewith, from their coalition may result those stones we call transparent gems. For 'tis certain, that bodies which were, a while before, in the form of water, may coagulate into stony *Stiria*; and that diamonds themselves, the hardest of gems, were once fluid substances, I hope we have already proved.

*The forma-  
tion of gems.*

But farther, having procured some petrified bodies from a place in *England*, I found that the petrifying juice, or spirit, which abounded in that spot of ground, was so penetrating and operative, that it ren-

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der'd some of the vegetable substances, found there, of their pristine shape and bigness, hard enough to cut both glass and iron. And from among these I pick'd a transparent body, that by the shape and other circumstances I judg'd to have been a diaphanous gum, belonging to a piece of petrified wood, which was hardened to a degree that made it capable of scratching glass.

*Their virtues, whence?*

To apply these particulars to our subject: I conceive that some of the real virtues of gems may be derived from hence, that whilst they were in a fluid form, the petrescent substance was mixed with some mineral solution, tincture, or other impregnated liquor; and that these were afterwards concoagulated, or united and hardened into a gem. And as several virtues of gems may, in general, be deduced from the commixture of these mineral corpuscles; so the greatness and variety of their particular virtues may proceed from the peculiar nature of the different impregnating liquors, and from the proportion wherein they are mix'd with the petrescent juice.

To render this conjecture the more probable, it must be remembered, that we have already shewn gems to have once been fluid or soft bodies; and that several of them were not simple concretions of a petrescent liquor, but consisted also of other mineral adventitious parts; as appears from the separableness of such substances in some stones, the specific gravity in others, and the different tinctures to be met with in gems of the same species, as rubies, sapphires, granats, and even diamonds; of which, as I formerly said, I have seen some yellow, some of other colours, and some green, almost like emeralds.

Since, then, there may be in gems, and in some of them numberless adventitious corpuscles; since there is cause to think, that some of them may be endowed with several properties and medicinal virtues; since there is a great difference among these impregnating particles, and, probably, a greater variety than is known to us; and, lastly, since many gems are richly impregnated with these particles, I see no reason why some of the virtues of several gems may not proceed from hence, rather than from those unintelligible and precarious substantial forms to which they are usually refer'd.

*Whether gems have, really, any medicinal virtues?*

It may, however, be objected, that the mineral substances cannot well have any medicinal operation on the human body, because they are so lock'd up as to communicate nothing to it; being unconquerable by so small a heat as that of the stomach, and other parts. Now, if there had never been any actual trial made, to shew whether a gem be capable of medicinal virtues, I shou'd find probability enough in this objection, to suspend my judgment till experience determined the question. But since, upon very credible testimony of eminent physicians, and patients themselves, of my own acquaintance, I find cause to assent to some matters of fact about the operation of gems; and since such facts strongly argue, in the general, that a precious stone may have medicinal virtues, I think the objection sufficiently



ently enervated by such particular instances; so that it ought not to keep us from assenting to the possibility of the thing, especially when there are other particulars to be alledg'd in favour of our hypothesis. For vigorous load-stones emit copious effluvia; and tho' they are usually a hard sort of stones, I have met with some, possibly, much harder than several gems. And 'tis farther considerable, that there are magnets which have a manifest and inconvenient operation upon the human body, by being wore in the pocket, or long held in the hand.

But farther, I have found several transparent pebbles, some of which, by being barely well cut and set, are made to counterfeit diamonds, that may immediately be brought to emit copious and strong scented steams. And if electrical attractions be owing to the effluvia of bodies, excited by rubbing; very slight alterations may suffice to procure expirations from transparent gems, many of which are electrical, and even the hardest of them, diamonds themselves; one of which I keep by me, that upon a little friction attracts very vigorously.

And as to that part of the objection which pretends, gems are not to be digested by the heat of the stomach; I will not stay to examine how far the digestion of things, in the stomach, is owing to heat. But to make the objection valid, it should be first proved, that such materials can have no operation upon the human body, while they pass thorough it, without undergoing any sensible change of bulk, figure, &c. as gems, when swallow'd, are supposed to do. For some chymists make bullets of the regulus of antimony, which they call *Pilula perpetua*; because when they have perform'd their operation in the body, and are thrown out with the excrements, they may be employed again and again to the former purpose: nor do we know what analogy there may be between some juices in the body, and those parts of mineral substances that impregnate gems. For tho' the *Oculus mundi* is reckon'd among the rare gems, yet if one of the best sort be, for a while, kept in common water, it will, as experience assures me, receive an alteration obvious to the eye. I might here alledge the concurrent authority of many physicians, and the common practice of most, who, in their public dispensatories as well as private prescriptions, order the fragments of precious stones to be taken inwardly, upon account of the virtues ascribed to them. But I wave such arguments as seem suspicious. However, I my self have, without heat, obtained a manifest tincture from several hard bodies, and even from a transparent sort of gems, by means of a faint liquor distill'd from a vegetable substance, which is as temperately qualified and as plentifully eaten as bread. And whether some juices of the body, assisted by the natural heat thereof, may not serve for menstrua to some gems, I cannot with certainty say. But even the natural heat of a human stomach, nay, perhaps, of the external parts of the body, may be able, tho' not to digest precious stones, yet to fetch out some of their virtues; since, I am sure, it makes a sensible alteration in the hardest sort of them.

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For I have a diamond, whose electrical faculty may be excited without rubbing, only by a languid degree of adventitious heat; and had in keeping another, which, by means of water made a little more than lukewarm, I cou'd bring to shine in the dark.

If it be further alledg'd, that tho' some virtues be allow'd to gems upon account of the minerals that impregnate them, yet 'tis impossible those virtues should be very great and various: I reply, that I desire no man to believe all the strange things, that even some learned writers ascribe to such stones; for the rarity of transparent gems, their lustre, and the great value which their scarcity, and mens folly give them, emboldens some to say, that such scarce and noble productions must be endowed with proportionable qualities.

But for a further answer to this objection, 'tis not improbable that there should be in the earth a much greater variety of minerals dissoluble by the subterranean menstrua, and capable of concoagulating with petrescent juices, than authors have yet taken notice of; as many subterranean productions, that I have met with, strongly incline me to believe. And from the number and various mixtures of these, may proceed not only a great variety of operative particles in precious stones, but a high degree of energy in some of them.

Next, I consider, that the efficacy of those mineral tinctures, or solutions, already known to us, may be reasonably presum'd greater in some gems, whereof they became ingredients whilst in *solutis principiis*, than can be expected from the vulgar solutions of the same metals or minerals, after they have, by vehement fires, been reduced into gold or silver, lead or antimony, &c. For in such vehement fusions as are requisite to bring metalline ores into these substances, the volatile and spirituous parts will be driven away, and the remaining body become more hard and compact, and thereby have its virtues lock'd up. But in their state of fluidity, those subtile and efficacious parts are preserv'd and united to the other ingredients of the gems, whence some of them may be easily drawn out; as I lately instanc'd in very hard pebbles, which afforded strong scented effluvia. And from the greater or less plenty, and natural activity of the impregnating particles in a gem, may, probably, be deduced the difference of the colour in some, and of the virtue in others of the same denomination: of the latter case, we have eminent examples in some learned writers; particularly in the *Lapis nephriticus*.

And here we may observe, that the petrescent juices themselves may have distinct natures, and be endowed with peculiar qualities, bystrating from those they acquire, upon account of their coalitions with adventitious liquors; as some differences I have found in petrescent fluids make probable. And having observed petrifying liquors or spirits, to pervade and give a high degree of hardness to bodies that nanced to lie within their reach, tho' one would have thought them inefficiently indisposed to receive such an induration; I see no absurdity

dity in supposing such a liquor may invade, permeate, and subdue transparent minerals, abounding in saline, sulphureous, and bituminous particles; which being duly excited, may emit their more subtile and active parts. And as I have cause to think, that subterranean fires and menstrua, do often make various compositions, and re-compositions in the earth; so 'tis not impossible that the spirit we are speaking of, may mix it self with such bodies, and petrify them, together with it self, into gems. I have had salt that was made by nature in the bowels of the earth, just like that the chymists compound by art. And I have sometimes, by an easie operation, and a moderate degree of fire, made a certain composition of volatile particles of salt and sulphurs, which, after distillation, shot in a fluid medium, into transparent crystals, more curiously figured than many natural gems. So that if either beneath, or upon the surface of the earth, such kind of substances happen to be pervaded and subdued by a clear petrifying liquor, we may well presume, that the resulting concretions will be endued with qualities, both uncommon in kind, and considerable in degree.

If it be yet objected, that it is very unlikely gems should part with any effluvia, or portions of themselves, since they lose none of their weight; and since some of them are very little heavier than crystal; I might leave physicians and chymists to reply, that the antimonial glass and cup imbue wine, and other liquors, with a strong emetic quality, without suffering any sensible loss of weight. But have the objectors tried the truth of what their argument supposes, by any method sufficiently accurate? This, I doubt, has neither been attempted, nor would be found easie to perform. And, till due experiments are made, let me represent, that tho' common water be not allowed a menstruum fit to draw any thing from mercury; yet both *Helmont* and others inform us, that a large quantity of it being kept for a day or two upon a small proportion of that drug, will acquire a virtue of killing worms; tho' the mercury retains its former weight. And this liquor is accordingly used for that purpose, and often with good success, in a great hospital in *London*; as the chief physician of it, a very judicious and experienced man, has more than once inform'd me.

And as for the lightness objected against some gems, it may safely be granted, that, *ceteris paribus*, such have more languid virtues than others of the same kind; but besides, the adventitious substance that impregnates the petrescent juice, may be of so small specific gravity, as not to make the gem at all heavier, in specie, than crystal. For this, as we formerly observed, being to common water of the same bulk, as about  $2\frac{1}{2}$  to 1; I have hydrostatically found, that several salts, and some other mineral substances, are of less specific gravity than that; and consequently, if these were concoagulated with the petrescent juice that hardens into crystal, they wou'd not increase its weight,



NAT. HIST. weight, tho' they might imbue it with considerable virtues. But, by the way, it is not necessary that the adventitious substance should be purely saline, to cause no alteration in the transparency of crystal, or the colour of other gems. For I have often made bodies, which, tho' transparent and colourless, like crystal, and sometimes curiously and regularly figured, were yet of a compound nature; and particularly abounded with a strongly scented sulphur that was easily separable therefrom. But, to give a more direct answer to the objection, I shall add, that tho' when a gem has a much greater specific gravity than crystal, or will allow an adventitious mineral to be separated from it, 'tis a very probable argument, that the petrescent juice is that body compounded with another substance; yet it will not necessarily follow, when neither of these signs appear, that the gem is quite free from such a substance. For the petrescent liquor, whereof it principally consists, may be impregnated with the finer and more spirituous part of the mineral, without having its specific gravity sensibly increased. Of this I received a notable instance from a mineral water; for tho' that water, by its inky taste, by its colouring the excrements of those who drank it, &c. appeared greatly to participate of iron; yet the particles of that metal were here so light and spirituous, as not only to fly away if the liquor were kept negligently stopped; but examining it hydrostatically, when fresh drawn, I found it very little, if at all heavier, in specie, than common water, compared and examined in the same scales, after the same manner, and with the same exactness.

If to all this be added, a consideration drawn from the atmospheres of solid bodies, and the great efficacy of effluvia, it will appear but natural to suppose, that some precious stones may have medicinal virtues; and that many of them may be ascribed to the mineral substances whereof they participate or consist; and especially to those which are best fitted to exert their powers, by a copious efflux of their more subtile parts.

'Tis true, what has been hitherto delivered, chiefly regards transparent gems; yet a great part of it may be apply'd to opaque ones. And if I have shewn, that even diaphanous gems may be endowed with virtues, by the mineral substances they contain, the arguments will hold more strongly as to opaque gems; for these are, for the most part, softer than the others; and 'tis far more easie to shew, by their specific gravity, and the mixed nature of several of them, that the dark ones may greatly consist of mineral substances, incorporated and hardened with petrescent juices. And among the several kinds of these liquors, I have observ'd one of so fine a substance, yet of so petrifying a virtue, that it will penetrate bodies of very different kinds, and turn them to stone, without sensibly increasing their bulk, or changing their shape or colour. By this means, I have seen several animal and vegetable substances so petrified, as scarce to be distinguished, by their appearance, from natural. Thus, for instance, a thin cream cheese was turned into stone, whilst the size,

*Animal and vegetable substances petrified, whilst their forms appear'd unaltered.*

shape,

shape, and colour, even of the wrinkles, and the bluish mould, were so well preserved, that it might easily have been thought eatable. I have also had a considerable quantity of wood so petrified in England, which retaining its former figure and grain, and being scarce at all visibly increas'd in bulk, was so very hard, that I cou'd make impressions with it upon iron, and even glass it self, and strike fire with it, as if it were an excellent flint: and the stony parts hereof wou'd not suffer the wood, which they had penetrated, to be reduced in the fire either to ashes or charcoal. I have likewise now by me a lump of mineral substances, wherein a petrescent liquor, that fills the large intervals between them, is transparent, and harder than most stones; as far as we cou'd guess by some trials made upon it, by a skilful engraver of gems.

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'Twere easie to add other instances of this kind; but these may suffice to shew it possible, for petrifying agents to insinuate themselves into the pores of various bodies, and turn them into stone; without otherwise destroying their pristine nature, or so much as altering their figure.

And now, to render our hypothesis the more probable, I shall offer a few arguments, drawn from the great specific gravity of several opake, medicinal stones; from the fitness of our supposition to account for several phenomena, some of which are scarce at all, and others much less probably to be accounted for without it; from the metalline substances, manifestly to be obtain'd from the stones we are treating of; and lastly, from the nature of the bodies whereof medicinal stones seem to be composed.

1. That the specific gravity of opake stones, whereto medicinal properties are ascribed, is very considerable, might have been easily discovered from hydrostatics, if the writers upon such concretions had been vers'd in that doctrine. Now, as marble is generally allowed to be a pure and solid stone, and, upon account of its whiteness, likely to be free from mineral mixtures, I chose that for the standard of the specific gravity of opake stones; and, accordingly, having weighed a piece of it, in air and in water, I found it to be to an equal bulk of that liquor, very nearly as  $2\frac{7}{10}$  to 1. And to make trial in a stone uncoloured, but suppos'd of a closer texture, we examined a fine white pebble, and found it was to an equal magnitude of water, as  $2\frac{6}{10}$  to 1. Hence 'twas easie to infer, that several bodies, which commonly pass for mere stones, are more ponderous than white marble of the same bulk; and that if there were any great excess in the specific weight of stones, above that of marble, it might proceed from some metalline body, mixed with the petrescent matter thereof. And I soon found, by weighing the following minerals, first in air, and then in water, that a blood-stone was to an equal bulk of water, as  $5\frac{7}{10}$  to 1; the load-stone as  $4\frac{6}{10}$  to 1; *Lapis Calaminaris* as  $4\frac{7}{10}$  to 1; and *Lapis Tutia* very near as 5 to 1.

Opake stones, examin'd hydrostatically, and thence shewn to be mixed with mineral substances.

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But I have not found the proportion of each of these bodies to water, to be any thing near constantly the same; but sometimes to differ very much in particular stones of the same kind; which agrees very well with our hypothesis: for, according to that, the stones which happen to partake more plentifully of mineral substances, heavier in specie than stone, ought to be more ponderous than others of the same kind that are not so qualified. From jet, a fossil found in some parts of *Europe*, which is reckoned among stones, and worn by many as a gem, I obtained no inconsiderable proportion of oil; and having weighed choice jet it self in water, I found it to be bulk for bulk to that liquor, but as  $1\frac{2}{3}$  to 1. And there are some other fossils, hard as stone, and polishable as marble, from which I have, by distillation, obtained two kinds of oil, whereof one was lighter than common water; which shews, that even bituminous and light substances may be ingredients of a stone: and that salts, which are most of them lighter in specie than white marble, may plentifully concur to the making up of stones, will appear from those, whereof we in *England* make vitriol. Stones, therefore, which are lighter in specie than white marble, may be compounded of fossils, and thence derive peculiar qualities; at the same time that such as are considerably heavier than that, may justly allow us to suspect, they owe their gravity to the mixture of metalline or mineral substances.

The manner  
wherein gems  
and stones are  
found to grow.

2. I have learn'd of travellers returned from the *East-Indies*, that sometimes one sort of transparent gems, sometimes another, and sometimes even diamonds themselves, are found included in the rocks, or in the midst of hard, loose stones, which must be broken in pieces before they can be obtained. Which phenomenon is hard to solve without our hypothesis; but according to that, it may rationally be suppos'd, that the gem was first formed, either in earth, or some other soft and permeable substance; which being afterwards pervaded by some petrifying juice, was turn'd into rock, or loose stones, according as the earth, and other ambient matter, chanced to be an entire and coherent mass, or divided into clods and parcels. And the governour of an *American* colony having sent me, among other curiosities, an odd kind of mineral, that seem'd more ponderous than at first sight it promis'd; I had the curiosity to break it, and found up and down therein several gems; which, by their figuration, and some other circumstances, were concluded to have been form'd there, before the ambient mineral had obtain'd the nature it then appear'd to be of. And it may happen in opaque stones, that a great lump of medicinal earth shall be invaded and petrified after the same manner. Whence it need not seem strange, that some medicinal stones shou'd be very large in comparison of others. Thus I remember, a physician told me of a spleen-stone in the hands of an acquaintance of his, which weigh'd 80 *lb*; and I have seen lumps of medicinal stone, much harder.



harder and heavier than marble, that were far greater than I cou'd lift: and having caus'd a pretty big piece to be violently broken off from the mass whereto it belonged, and to be sawn asunder, I found several empty cavities, of different sizes and figures, in the solid substance of the stone; which seems to argue, that this compact and ponderous body was made stony, by the supervention of some petrescent liquor upon porous earth, or other consistent substance. For if it had been a mere liquor, wherein those cavities were so many aerial bubbles, 'tis not probable, that some of them shou'd have such irregular shapes, and that all shou'd have continued without emerging to the top.

Our hypothesis will also help us to explain, how some gems, which seem to be entire stones, are of different colours in contiguous parts; as the sardonix, and some other opaque gems: I have, also, observ'd the like, tho' rarely, in diaphanous ones. For, according to our hypothesis, it may be said, that a portion of matter imbued with one of the tinctures of the party-colour'd gem, was first form'd; and afterwards some petrescent juice, endowed with another colour, came to settle contiguous to it; and so by accretion made up one stone with it. This might be illustrated by considering, that tho' fire makes a far greater agitation of the bodies melted by it, than need be suppos'd in cold petrescent liquors; yet I have found, in making artificial gems, that by some mischance, or error, in the operation, the mineral pigment has richly tinged one part of the transparent mass, without at all imparting that colour to the very next part to it. One of these I have yet by me, which wou'd be judg'd to consist of two differing gems subtilely glew'd together.

But in natural gems, the union of parts might be the more perfect, if the supervening matter found not the stone first form'd, to have attained its full induration. Tho', for ought I know, even in this case the apposition may be so close, and the two materials so near of kin, that they may both pass for one stone, and be polished together; without any discontinuity appearing in the surface: for I have by me, a lump, wherein there plainly appear stones of very different colours from each other, that were once distinct and incoherent; but by some petrescent liquor, have had all their intervals so exquisitely fill'd up, that neither the touch, nor the artificer's tool, when the lump was sawn asunder, cou'd discover any commissures; but the whole mass bears an uniform polish, and is harder than several gems that are worn in rings, and will readily strike fire with a steel. And for farther confirmation hereof, in the place where this portion of petrified matter was found, not only other lumps, but many loose stones were discovered, which seem'd altogether of the same nature with those, that by the supervention of the petrescent liquor, were united into stony masses. I have, also, had a curious agate so form'd, that it seem'd highly probable, that the opaque parts of its matter

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had been some thin separate beds of fine clay or earth, lying almost parallel to each other; which, by a petrescent liquor that settled there, was reduced to coagulate with it into a stone, partly opaque, and partly diaphanous. And of such clays or mineral earths, I have observed more than one or two, which, tho' distinct, and, perhaps, of different colours, yet the thickness of them all scarce exceeded an inch; nor did they always lie flat or horizontally, but in differing postures, both with regard to the horizon and one another; and now and then the exterior ones, successively, almost surrounded the interior. And of these thin couches or layers of earth, I have found a considerable number within a very small compass of ground. The production of several other gems, as chalcedonians and jaspers, which are generally opaque, but have some parts transparent, may also, probably, be explain'd in the same manner. 'Tis here remarkable, that by purposely calcining some of these stones entire, whose greater part was diaphanous, I found that the transparent parts turn'd white, and that some of the thin couches of mineral earth had retain'd, not only their position, but their colour, which seem'd much heighten'd; so that one of these layers, after calcination, appeared of a very rich and permanent red. And this difference of colours, I observed, not only in layers, but in the specks and irregularly shap'd clouds of other colours. I might here add, that I have found shining marcasites, not only in other solid stones, but in marbles and flints themselves. Thus, also, I have found wood in strong stones employed to build houses, and shells in a great mass of stone, that I met with almost on the top of a hill, remote from the sea. Now these, and the like phenomena, may be, probably, accounted for by our hypothesis, and scarce without it. But even in transparent gems, and which is more, of the same species, I have sometimes taken notice of such an accretion of stones as argues their having been produced at several times. For proof of this, I need only repeat what I formerly said of those *Cornish* diamonds, wherein, sometimes, a lesser stone, tho' geometrically shap'd, was found in good part inclos'd in a greater, and in part, also, extant above it; whence I argue, that the production of this aggregate of two crystalline bodies, was not made all at once, but successively; and that the lesser was first formed; which I shall now confirm by this consideration: that if the greater stone had been first harden'd, the matter of the lesser must only have stuck to it externally, and been, as it were, imbofs'd upon it; but cou'd not have made it self a bed, or mould, in the substance of the greater, especially of such a geometrical figure as it self had not yet receiv'd.

I caused two solid fire-stones, supposed to be uniform and entire masses, tho' of very different sizes and shapes, and brought from distant places, to be warily broken; whereupon I observed that part of the internal texture of the least of these minerals, which was almost spherical, greatly differ'd from that of the more-internal substance; and  
that

that in the largest mineral there was a little globular stone, manifestly not of the same piece with the surrounding mass, but differing from it, not only in texture, but here and there by a discernible commissure; tho' in most places their adhesion was so strict, that we could not make any separation of the two minerals in this commissure.

And tho' this successive generation of the parts of entire gems, may appear somewhat new and strange; yet that its fitness to explain the foregoing phenomena, and others, may the more recommend it, I shall here give it a mechanical illustration. We see, then, in several chymical solutions, as of salt and other bodies, that there are certain stages or periods of coagulation; so that when such a quantity of the superfluous moisture is exhaled, especially upon any considerable refrigeration, or other favourable circumstances, those particles that are most disposed to coagulation, will convene and shoot into crystals, after which, no more will shoot till a farther evaporation be made; but upon a repetition hereof, a new crystallization of the parts will ensue. And I can shew the productions of a metalline solution, so made in an appropriated liquor, that the first shooting afforded a layer of curiously figur'd crystals; and the following, another of fine crystalline bodies, that have fastened themselves to the former, but differ considerably from them both in shape and posture. And in this experiment, both the dissolved materials and the menstruum, were single bodies. But if there be a diversity of nature in the liquors that make up a menstruum, or in the bodies that are dissolved in it, some of the corpuscles may convene, either a-part with those of the same nature, or as mix'd with those of a different one at the same time; and so make up crystals of a compound nature. Some of them, also, may convene with homogenous particles, at different times, and so fail of such an uniformity as might otherwise appear in their concretions. This may be illustrated by the crystallizations of salt-peter and sea-salt, dissolved together in common water, whence grains of salt of the figures thence resulting, are usually produced; and, also, a considerable part of the sea-salt coagulates in the form of imperfect cubes, about the bottom, before the nitrous corpuscles shoot into crystals of their own prismatical figure: and it matters not whether the superfluous water be exhaled or drawn off by a material fit to soak it up; as we have had occasion to observe in accelerating the crystallization of some bodies.

In conformity with such instances as these, we may conceive, that where there are petrescent liquors mix'd with common water, there may by several accidents, and particularly by a hot summer, be made a sufficient discharge of the superfluous moisture, to cause the more disposed parts of the petrescent liquor to coagulate; and afterwards the coagulation may be suspended, either by the supervision of a colder season, or even in summer it self, by a plentiful rain, or the effect of it, a land-flood, which might check the progress of such coalitions, by diluting the fluid which would otherwise have turned into stone.

And



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And trial hath assured me, that there are bodies of very different kinds, which will, in tract of time, especially if their coalition be farther'd by cold weather, coagulate after they have long remained fluid; tho' the water, or other menstruum, by being enclosed in stopp'd glasses, be kept from wasting. And since the earth harbours different kinds of these liquors, and many of them may be copiously impregnated with one sort of mineral or other, they may have distinct periods for their respective coalitions, and yet stick close to one another. For tho' in chymical crystallizations we usually take out of the vessel, what shoots the first time, before a fresh exhalation be made for a new crystallization, and by this means find the coagulated bodies obtain'd at one time, more uniformly shap'd than at another; yet in the hollow receptacles which the earth affords to petrescent liquors, the vessel continuing the same from first to last, the uniformity of the bodies produc'd by coalitions, made at several times, must be less regular, and the manifest accretions of coalescent bodies, in all likelihood, be more frequent. And, accordingly, having long continued the exhalations of some liquors, in the same vessel, I had coalitions of very different bodies at the bottom. I might add, that in some circumstances, even in these vessels, and therefore without any manifest exhalation of the water, or other menstruum, and, sometimes, where the dissolved body was homogeneous, I have, in process of time, had coagulations, where the crystals last formed seem'd plainly to have been generated by way of accretion to the first.

Whence it  
is that stones  
of various  
kinds, petrified  
animals, &c.  
are found in  
dry places, so-  
lid rocks, &c.

I shall now endeavour to clear a grand difficulty, which I foresee may be objected to our hypothesis; namely, that these accretions, of medicinal or other stones, are, sometimes, found in places where there are no petrifying springs, and, perhaps, no water at all; nay, little or nothing but quarries, or masses of stone.

To this I answer: first, that if we admit the relations of approved authors, concerning men and beasts being suddenly turn'd into stone, by a petrifying spirit; it is not absolutely necessary there should be any petrescent springs, or other water, to produce such minerals as we are speaking of.

(2.) For any thing that has hitherto appeared to the contrary, we may suppose that rain-water, sometimes, brings along with it such petrifying particles as may serve our turn. I am informed, by a judicious person, who visited a famous bath in *Hungary*, the water whereof greatly abounds in petrescent particles, that to the roof of a tall structure which stands over it, there were fasten'd many long stony concretions, affirm'd by him to be generated there from time to time, not by the dashing up of any drops of water, which could not reach near so high; but by the copious petrific steams, that being there check'd in their ascent, coagulated, according to their natural propensity, into stone. Hence it seems not impossible, that stone should, in some places, be generated without the help either of rain or springs, by the ascent of petrific

trific particles in the form of exhalations, from the lower parts of the earth; which exhalations suffering the lighter steams that accompanied them to exhale, may operate upon some disposed materials which they find in their way, and turn them into stone; and indeed the earthy, and sometimes sulphureous sediments, that have been observed at the bottom of rain-water, suffered to settle in clean vessels, may seem to favour such a conjecture: which receives an illustration from what I observ'd in a bottle of distilled liquor, whereof no part wou'd naturally ascend in a dry form; but having kept it well stopp'd in a safe and quiet place for a year or two, the ascending steams had quite pervaded the cork, and formed at the top of it numerous, whitish, slender *Stiria*, of a surprizing length.

(3.) There is no necessity that in all soils where petrific waters are found, petrifying springs should appear, at least above ground; for I have seen numberless figured, and transparent stones, dug up in a certain earth, that lay upon the upper part of a rock, and seem'd to be a very dry soil; and by pouring a solution of stony *Stiria*, made with spirit of verdigrease, on a convenient quantity of bole-armeniack; and suffering the soft mixture to remain in a glass in the open air, till the superfluous moisture was exhal'd, I have found small, unting'd, figur'd crystals, dispers'd thro' the little cavities of the red earth. But 'tis considerable to our present purpose, that the fairest and hardest petrified wood I ever tried, was taken up in a plot of sandy ground, where no petrifying spring, or other water, was to be found. And supposing the ground to have been once moistened by a petrescent liquor, brought thither by springs, or any other way; our hypothesis will shew how, on the surface of the ground, and perhaps upon rocks themselves, aggregates of figured stone may happen, that seem to grow upwards, as it were, from a root; which usually puzzle men to know how they came there; and may incline them to ascribe vegetation to stones. But to this it may be reply'd, that many of the concretions might have been formed in wombs, that lay, tho' not deep, yet under ground, or in shallow cavities, in the surface of it; and that after their formation, the looser earth, which surrounded them, may have been wash'd off by rains, blown off by winds, or otherwise remov'd; leaving behind them these stones that adhered firmly to a solid body. 'Tis also very possible to shew, that stony concretions might be produced by the mechanical action of the air upon the stony particles, which successively apply themselves to the matter that first begins to coagulate, when they are ready to be forsaken by the moisture that accompanied them, and was necessary to their due application to the casual rudiments, which pass for roots; in imitation whereof, I have more than once obtain'd, both from saline and stony solutions, dry tufts of prettily figured, diaphanous, or white, slender *Stiria*, that seem'd to grow out of the

NAT. HIST. containing glass, and made persons wonder how they came there; no water, or other liquor, appearing near them.

(4.) It may easily happen, that the petrescent liquor shall be so mixed and diluted with ordinary water, as not to be distinguish'd from it, nor be capable of disclosing itself by its effects; till either by a large exhalation of the common water, or by some peculiar advantages it has to operate upon bodies, it gains a proper opportunity. There is a lake in the north of *Ireland*, wherein fish live, as well as in other lakes; tho' there are some rocks at the bottom of it, to which many masses, and pieces of a finely figur'd substance, transparent as crystal, fasten themselves. Now if we suppose, that either by springs of petrescent water, or by rains, or by subterranean steams, or, otherwise, waters resting in any hollow place, tho' upon the tops of rocks or mountains, shall be sufficiently impregnated with petrific particles; and that afterwards, in process of time, the merely aqueous parts shall gradually, by the heat of the sun, the soaking of the ground, the winds, or the continual action of the air, be brought to exhale away in the form of vapours; the petrific particles, which are not so volatile, will turn the soil beneath them, and on the sides of them, as far as the sphere of their activity reaches, into stone, harder or softer, and into this or that kind, according to the particular nature of the petrescent liquors, and the structure, and other dispositions of the soil they invade; in which soil, if there chance to be lodg'd bodies heterogeneous to it, whether vegetable substances, as roots, gums, &c. the whole bodies of animals, as toads, frogs, serpents, &c. or their parts, as shells, bones, &c. or minerals of an open texture, as boles, unripe ores, or else gems, or stones of another kind already form'd; any of these things, or any other that shall chance to be lodg'd there, must be found either petrified, or inclos'd in stone, when this harden'd soil shall come to be broke up. Nor is it at all necessary, that such petrification of the extraneous bodies, and of the soil or bed, be made at once; for it may well happen successively, at several times, according as some parts of the petrescent juice are more copious and penetrating; and consequently more fit to be soaked in, further than others. For as the porosity happens to be greater in one part of the soil, than in another; or as the texture and disposition of the particular bodies lodged in the earth, give advantage to the petrifying particles to work on some of them sooner, or in a different manner than in others; so the induration of the pervaded substances may be very unequally made in point of time, as well as in other circumstances. Whence it appears, how medicinal stones, of very different colours, consistencies, and operations, may be generated, and seem entire bodies, tho' one part of them be dark, heavy, and opaque; and the other much lighter, transparent, and quite of another colour. And upon the same principle may be explained, the manner wherein diamonds are inclos'd in



in loose stones, or even in rocks; of which we have credible testimony. Nor does this appear more strange, than that a stone, which I have by me, a kind of pebble, should contain a perfectly shap'd serpent, coiled up in it, without a head; which seems to have been form'd before the stone, because in the upper and lower parts of that solid, there are cavities left, that together make up one entire cavity, just of the size and shape of the contained body; whereto, as it was easie for the matter of the stone, whilst soft, to accommodate it self exactly; so 'tis scarce conceivable how, if the pebble had been first form'd, the inclos'd animal, if it were one, or the matter in that form, should not only get in, but find a cavity so curiously shap'd, and fitted to its bulk. And that this variety was produced at several times, might be farther argued from hence, that the seeming serpent is plainly another and clearer kind of stone, than that of the mould which includes it; and of the mould it self, one part contiguous to the included body is whitish, and abounds in shining grains, or flakes; in both which it differs from the other, which is far the greater part.

(5.) In those very places, where now there is nothing to be seen but loose stones, there may formerly have been petrescent liquors, either stagnant or running; for earthquakes, inundations, sinkings of the ground, incroachments of the land on the water, fiery eruptions, and such accidents, may, among other odd effects, have dry'd or choak'd up pools and lakes, and quite stopp'd, or diverted the course, both of springs and rivers, so as to leave no remaining signs of them. Upon this account, and other great changes in the structure and disposition of the soil of several places, it may well be suspected, that the stony moulds, wherein the above-mentioned bodies were found, might heretofore have been of an earthy nature, and the receptacles of petrescent liquors, which, at several times, turn'd the whole mass of the soil into stone, before the springs, or other waters, containing the petrific liquors, were quite consumed, or had their course altogether diverted. And many things might be produced to strengthen this conjecture.

3. It agrees very well with our doctrine about the great specific gravity of these stones, in comparison of white marble, or transparent pebbles, that it is possible out of them, to extract some of the substance suppos'd to give them that additional ponderosity. And, accordingly, we have, by appropriated menstrua, obtained from such bodies, solutions or tinctures; which, not to insist on their colour or taste, wou'd, upon their being dropt into a tincture of galls, or other convenient liquor, produce such phenomena, as argued them to abound with metalline or mineral particles; which, for the most part, I observed to be of a vitriolic nature. Thus I found, that the solution of a blood-stone, which tasted very rough upon the tongue, wou'd with the infusion of galls, make an inky mixture; and the

*The tinctures and solutions of stones abound in metalline or mineral particles.*

**NAT. HIST.** like happened with load-stone, emery, marcasites, &c. open'd by corrosive menstua. But the solution of *Lapis Calaminaris*, which was of a golden colour, did not operate like the rest on the infusion of galls; yet by its tast, as well as colour, sufficiently shew'd it self to have copiously impregnated the menstruum. The mention of *Lapis Calaminaris*, reminds me of an instance of there being other ways, besides that of dissolution, in proper menstua, to shew that some medicinal stones participate of metalline and mineral substances; for it is by melting this stone with copper, and keeping them together for a competent time in fusion, that brass is made; wherein the red colour of the copper is changed into a golden one, and the absolute weight considerably increased. Nor is this the only mineral stone from which I have, by a way quite different from those hitherto mention'd, namely, with running mercury, obtained a metalline substance. And tho' native cinnabar be looked upon by the vulgar as a red stone, yet 'tis known, in the quick-silver mines, to be a mercurial ore; whence, by vehement fires, they distil running mercury, as we by a moderate one have sometimes done.

Even the  
lighter stones  
may be mixed  
with metalline  
matter.

There are, however, some stones, that have useful qualities ascribed to them, tho' they appear to be not at all, or so little heavier in *specie*, than is requisite for a mere stone, as to render it very unlikely, that metals, or ponderous minerals, should contribute to their production or virtues.

But our hypothesis does not oblige us to deny, that there may be such stones; for tho' it ascribes the virtues of most gems and stones to the metalline and ponderous mineral substances they partake of, yet the concession agrees very well with our doctrine; which teaches, in general, that the virtues of stones may, in many cases, depend upon their being impregnated with other minerals; which, tho' they most commonly prove specifically heavier than the mere petrescent matter, yet in several stony concretions, the adventitious ingredients may be specifically lighter than the genuine matter of the stone; as we have formerly seen in several bodies which pass for stones. Thus not to repeat what has been said of salts, I have observed that some other hard fossils abound with a kind of bitumen, which, when, by distillation, brought to an oil, is much lighter than a stone of the same bulk; and I have had some portions of such oil that would swim even upon common water. And lest this should be ascribed to the subtilization the bitumen received from the fire, I will add, that having hydrostatically weighed a piece of good *Asphaltum*, we found it to be to water of the same bulk, but as 1, and somewhat less than  $\frac{4}{5}$  to 1; which was within a tenth of the proportion of a stony bituminous fossil to water, commonly call'd in *England*, *Scotch* coal. And because sulphur, as well as bitumen, is very apt, even by a moderate heat or attrition, to diffuse its steams; let it be noted, that there are various hard stones which abound in sulphur; and yet having

having weighed a roll of brimstone in air and water, I found it to be but a trifle above double the weight of the latter, which shews it was much lighter *in specie* than crystal. NAT. HIST.

Hence we may argue, that 'tis not impossible the principal virtue of a light medicinal stone, should be due to some mixture of a metalline, or the like ponderous substance; since if some of the ingredients that are plentifully mix'd with the true stony matter, be of the lighter sort, tho' there be also some metalline, or other heavy mineral particles mixed with the same matter; yet the less specific gravity of the one, in comparison of this matter, may compensate for the greater of the other; and so together compose a stone not more ponderous than white marble. Thus I have found a blackish *East-Indian* flint, and likewise a black *English* one, to have to water not full the proportion of  $2\frac{6}{10}$  to 1; and that a piece of black marble, which I examined hydrostatically, was, notwithstanding the darkness of its colour, to water of the same bulk, scarce any thing more than  $2\frac{7}{10}$  to 1; which is the proportion I found between white marble and water: tho' it may perhaps be said, that this blackness of colour proceeded not so much from any gross, bituminous matter incorporated with that of the stone, as from some mineral smoke that had pervaded it.

And it seems not impossible, that the matter which medicinal stones are made of, may, before it comes to be harden'd, derive various colours, and be endowed with virtues from subterranean exhalations, and other steams. For that many parts of the lower earth emit copious exhalations into the upper, and even into the air it self, I presume will be readily granted; that also such subterranean steams will easily mingle with liquors, and imbue them with their own qualities, may be inferr'd, from the experiment of mixing the scarce coagulable fumes of kindled and extinguished brimstone with wine and other liquors, which are thereby long preserved; and that beneath the surface of the earth, there are sulphureous and other steams, which may be plentifully mixed with water, and in all likelihood with petrescent liquors, is with me beyond all question.

*The matter of medicinal stones may, whilst fluid, receive virtues and a colour from subterraneous exhalations.*

That quick-silver may, in part, be resolved into fumes by less fires than many of those which burn under ground, will be readily acknowledged by chymists and gilders, and is obvious from the fumigations employed in the cure of the *Lues venerea*; and that mercury may in the bowels of the earth be so disguiz'd and well mix'd with stony matter, as to suffer the whole concretion to pass for stone, may be observed in some kinds of native cinnabar.

That sal-armoniac will, with a moderate fire, be made to ascend in form of exhalations, is vulgarly known, as to the factitious salt of that name; and I have found it to hold true in the native. That common sal-armoniac, sulphur, mercury, and tin, will sublime into a gold-like substance, participating of most, if not all the ingredients, has



**NAT. HIST.** appeared to me from a particular experiment. That even gold itself may, with a small addition, be made, by a moderate fire, to ascend in the form of fumes or flame, I have several times tried. And, lastly, that mineral exhalations may be met with in the bowels of the earth, is witnessed by many credible persons and eye-witnesses, skilled in minerals. And this, some things that I myself have seen, incline me to believe. Such an ascent too, of mineral fumes, and even of metalline ones, may, also, be much confirm'd, not only by the writings of chymists, but by the learned and curious *Kentman*, who, in the useful catalogue of the *Misnian* fossils, reckons amongst the *Pyrita*, one whose title is *Pumicosus*, and tinged of a black colour by a fiery exhalation; and another of a silver colour, tinged grey by a poisonous exhalation. And the same may be farther confirm'd by a relation of the learned *Cabeus*, as to what he found in the territory of *Modena*.

Since then there are mineral exhalations of very different kinds, dispers'd in many places under ground; and since there are several volatile minerals, as arsenic, orpiment, sandarac, &c. that are very actively hurtful, there may others be endowed with medicinal qualities; and the exhalations of such minerals, either alone, or mix'd with petrescent liquors pervading duly disposed earths, boles, or other fluid, soft, open substances, before their induration, may impregnate them with medicinal and other qualities.

And even  
when more so-  
lid.

Nay, when I recollect the odd phenomena, that I have partly observ'd, and partly received from credible testimony, about the coalitions, mixtures, tinctures, and their effects, in metalline, stony, and other fossil concretions, I dare not peremptorily deny, that, even after subterranean bodies have obtain'd a considerable degree of induration, and, perhaps, enough to make them pass for stones, there may be subterranean steams able to penetrate, tinge, and otherwise impregnate them; which seems the less incredible from what was just now related out of *Kentman*, and especially from my own experiments, made to tinge native crystal with different colours, by the fumes of volatile minerals. And that a very small proportion of a metalline substance, resolv'd into minute particles, may impart a tincture to a great quantity of other matter, duly disposed, appears from those factitious gems, wherein, with three or four grains of a metal, skilfully calcined, or some mineral pigment, we can give the colour of a natural gem to a whole ounce or more, of a vitrified material. In more subtile fluids I have made the instance, vastly more conspicuous, by tinging with one grain or less of a prepared metal, as gold or copper, as much phlegm, successively generated, as would, if it could have been all preserv'd, have amounted to a bulky quantity of deeply colour'd matter.

Some ingre-  
dients of opake  
gems, and me-  
dicinal stones,  
may, before  
they received  
this form,  
have been com-  
plete minerals.

4- The last thing I shall produce to shew, that the virtues of opake gems and medicinal stones may be more easily, than those of transparent ones, accounted for on our hypothesis is, that the principal ingredients, whereof many such opake stones consist, were complete mine-

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ral bodies before they were petrified; some of them having been medicinal boles, or the like earths; some earths abounding with metalline or mineral juices; some ores of metals or minerals of kin to metals; and some, in fine, bodies of other natures, differing from these and from one another. For all such several kinds of fossils may, by the supervention and pervasion of petrific spirits, be turned into stone; and consequently, retain many of the virtues they were endowed with by the mineral corpuscles that had copiously impregnated them, whilst they remained bodies of a more open or penetrable texture.

I might illustrate this from the methods whereby I made such mixtures of stony and metalline ingredients, as notwithstanding their coalition, were transparent; tho' that be more difficult than to compound such concretions when they are designed to be opake. But here, again, I must obviate an objection, that may be made to the present argument. For since it seems, by our doctrine, that gems may be only magisteries, and consequently but such compositions as, tho' made in the bowels of the earth, might be imitated by human skill; it may appear very improbable to many, that bodies, so near of kin to artificial ones, should possess such peculiar and strange virtues as are ascribed to several gems, and thought capable of flowing only from certain very noble substantial forms.

To this I might reply, that I admit not any such imaginary beings, as the peripatetic forms, which, I believe, will never be demonstrated to exist. But to avoid unnecessary disputes, I rather answer, in short, that such compositions as are called artificial, may, nevertheless, be endowed with great virtues, and such as are called specific; witness the virtues of many chymical preparations, even of those that are used by physicians of all sorts; nay, even *Galen* himself will furnish us with instances to our present purpose. For to the ashes of crawfish, which, notwithstanding the destruction that has been made of their pristine body by fire, he gives a greater commendation against the bite of a mad dog, than to the fish it self unburn'd, or to any medicines of nature's providing: and a virtue of that kind and degree will surely be allowed specific. And the *Theriaca*, tho' a factitious body, and consisting of a multitude of ingredients huddled together, was yet, in the days of *Galen*, esteemed a most famous antidote; and has since been celebrated, not only for its alexipharmic virtues, which alone are sufficient to entitle it to a specific; but for many others, either upon account of its manifest or occult qualities.

But farther, according to our way of explaining the production of medicinal stones, a probable solution may be given of this difficult phenomenon, that, sometimes, stones allow'd, without scruple, to be of the same kind, are of such different qualifications, that some of them prove very considerable remedies in cases where others are almost ineffectual. And I have, sometimes, observed, that a medicinal stone may have virtues, supposed to be the properties of stones of another kind.

Whence stones  
of the same  
kind have dif-  
ferent qualifi-  
cations.

**NAT. HIST.** kind. For, according to our hypothesis, when the stony matter is impregnated as it ought to be, with those minerals that in the ordinary course of nature belong to its species, its virtue will be such as it should be for kind; but for degree may be very various, according to the quantity, purity, subtilty, &c. of the mineral that impregnates it. But if the stony matter chance to be imbued with some other substance of a contrary nature, tho' perhaps the proportion of it may be so small, and the colour of it such as not to render an alteration in the stone, obvious to sense, and considerable enough to make it judg'd of another species; yet it may so vitiate the matter, wherein its quality resides, or check and infringe its operation, as not to leave the stone any great degree of virtue. On the other side, if it happen that the mineral corpuscles, which usually impart a certain virtue to the stony matter of one gem, should, by some lucky hit, be so united with that of another sort, (of which I formerly gave an instance in green diamonds,) tho' the quantity of this unusual ingredient may be but very small; yet if its efficacy be great, it may ennoble the stone with a remarkable degree of some such virtue, as is supposed not to belong to that species, but to another. Thus I have been told of surprizing virtues in a stone for the stanching of hemorrhages; tho' by its colour and texture I should never have taken it for a blood-stone.

The subtilty and penetrating virtues of some liquors, if duly consider'd, may shew it to be possible, that such bodies should be petrified by them, as in part consist of animal and vegetable substances. Thus we see petrified shells, bones, and pieces of wood; and that soft stone, which is plentifully found near *Naples*, and commonly called *Lapis Lyncurius*, being rubb'd a little, moisten'd with water, and then exposed to the sun, in a due season of the year, will, in a very short time, as eye-witnesses have assured me, produce mushrooms fit to be eaten; as if even the seminal principles and rudiments of vegetables may be so preserv'd in a petrified earth, as to disclose themselves when they find an opportunity. And an eminent person, master of some of these stones, informs me, that they now and then find them of a vast bigness; as if whole masses of earth, pregnant with the prolific principles of mushrooms, were, by some supervening petrescent liquor, turned into stone.

*Various  
earths may be  
petrified, and  
contain surpris-  
ing, subtil,  
and medicinal  
parts.*

And not only boles, seal'd earths, and such like fossils, as are commonly known for medicinal, may be harden'd into stone by petrifying agents; but other earths, subject to petrification, may contain medicinal and subtil particles, of such a kind as seems scarce credible. I have seen a clay-pit, wherein, at a considerable depth from the surface of the earth, there lay a bed of clay, which, by distillation, yielded a salt so volatile and strong, and so different from other subterranean salts, that I could not observe the manifest qualities of it without wonder; and the owners of the pit, who were rich and curious persons, did themselves



selves use it for physic, and cried it up for an excellent cordial, a great opening and diaphoretic medicine.

Lastly, that sublimable salts, sulphurs, and bitumens, may be met with in the bowels of the earth, is certain; and that such substances may be found in bodies which pass for stones, I have been induced to think, by the chymical examination I purposely made of some such concretions; particularly of that solid and heavy one, commonly called *Scotch coal*; from whence I obtain'd, by distillation, a large proportion of oil, or liquid bitumen, and no small number of saline particles, that seem'd to be of an uncommon nature.

But enough of a subject, wherein, contrary to my custom, I have indulged conjectures; which, however, are the more excusable, in treating of the operations of nature in her dark and subterranean recesses; for here to have offered accounts that carry probability along with them, seems sufficient.



# OBSERVATIONS UPON DIAMONDS;

And particularly upon one which wou'd  
shine, remarkably, in the dark.

*Promiscuous  
observations  
upon diamonds.*

**D**iamonds being generally esteemed the most noble and precious of inanimate bodies, I cou'd not but gratifie my curiosity about them, by proposing questions, whilst a director of the *English East-India* company, to some *East-India* merchants and jewellers, who had dealt much with these gems.

And diamonds deserve the rather to be enquired into, because the commerce they help to maintain between the western and eastern parts of the world, is very considerable. For as small as their bulk is, their properties and mens opinion, so greatly recommend them, that, I remember, one of the most famous and intelligent merchants of this nation, assured me, that, according to his well-grounded estimate, there came of them from the *East-Indies* into *Europe*, one year with another, to the value of 350,000 *l. Sterl.* whereof about 100,000 *l.* came into *England*; which at present, by the prudent indulgence of the government, and of the *East-India* company, is become the mart of diamonds.

To prove the great hardness of diamonds, even in comparison of other bodies, that are thought wonderfully hard, a famous artist for cutting of these stones affirm'd to me, that he could neither cut or polish diamonds with any thing but diamonds; and that if he shou'd employ so rough a way, and such forcible engines to cut rubies, or any other stones, as he does to cut those, it wou'd presently break them in pieces; which, by the inspection of his engine, appear'd very probable.

A very skilful cutter and polisher of diamonds told me, that having dealt in them near twenty years at *Amsterdam*, and several years in *England*, he perceived there are of late brought over worse sorts of diamonds; so that he judges those of the old rock (as he calls them) either to be quite spent in the *Indies*, or, at least, to be seldom or never transported. And he finds several late diamonds, so soft and brittle, in comparison of those of the old rock, that he is often afraid, or unwilling to meddle with them, lest he should spoil them in the cutting or polishing.

Notwithstanding the wonderful hardness of diamonds, there is no truth in the tradition, that represents them unable to be broken by any external force, unless first soften'd by being steep'd in the blood of a goat. This odd assertion, I find to be contradicted by the frequent practice of diamond-cutters: and particularly, having enquired of one of them, to whom abundance of those gems are brought, to be fitted for the jeweller and goldsmith, he assur'd me, that he makes much of his powder to polish diamonds with, only by beating board diamonds (as they call them) in a steel or iron mortar; and that he has by this way made, with ease, some hundred carrats of diamond-dust.

'Tis a received opinion among many who deal in gems, that as diamonds are the hardest of bodies, so the same compactness, and their great solidity, gives them also a proportionable gravity, and makes them extremely weighty with regard to their bulk.

But a rough diamond somewhat dark within, that in a pair of scales which turn'd with the  $32^d$  part of a grain, weighed 8 grains, and  $\frac{8}{16}$ ; being carefully weigh'd in water, according to the rules of hydrostatics; it proved to an equal bulk of that liquor, as  $2\frac{2}{3}$  to 1. So that, as far as can be judg'd by this trial, even a diamond weighs not thrice as much as water.

Asking a famous and experienced cutter of diamonds, whether he did not find some rough diamonds heavier than others of the same bigness? he told me, he did, especially if some of them were cloudy or foul: and shewing me a diamond that seemed to be about the bigness of two ordinary pease, or less, he affirm'd, that he sometimes found in diamonds of that size, compared together, about a carrat (or four grains) difference in point of weight.

The shape or figure of diamonds is not easie to be securely determin'd. For those that are seen in rings and other jewels, having been, by way of preparation, cut and polish'd, change their natural figures for that which the artificer thinks fit to give them. And rough diamonds themselves (which are not easily met with) often come to our hands broken, tho' undesignedly, by the diggers; and are, therefore unfit to acquaint us with their genuine shape; which we may be unable to discover, because of the accidents whereto the matter they consisted of was subject in the mine. For having had a parcel of



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between 100 and 150, put into my hands at one time, in the *East-India* house, I found very few of them completely shap'd; but generally broken, and of very irregular figures, like those of so much gravel taken up at adventures upon the sea-shore. But some few appeared pretty regularly figur'd, which, probably, were not much hinder'd from shooting freely in the wombs or cavities, wherein they coagulated or concreted. And these seem'd to consist, in my opinion, of several triangular surfaces, that were terminated in, or compos'd several solid angles. And one rough diamond I had of my own, wherein this shape was more conspicuous, than I remember to have seen in any other. Besides, having enquired of a very experienced artificer, who fitted up these gems for the goldsmith, whether he found rough diamonds to be of any constant figure? he answered me, that he always observed those which had any regular figure, to be six-corner'd.

Diamonds have a grain, or a determinate tendency of their fibres, or rather of the thin plates they are made up of, as well as wood; and may, with ease, be split along the grain, tho' not against it. I have seen a very large diamond, that was cut, with the grain, into three pieces, whereof the middlemost, tho' large, and about the thickness of a shilling, was evenly thick, and exactly flat on both sides; and I possess a diamond-ring, whose stone I caus'd to be set rough, as nature produced it, because in that state the grain is manifest to the naked eye; (and much more when viewed thro' a glass, that moderately magnifies the several plates it consists of) having their edges distinguishable like those of a book a little open'd. An experienced cutter of these gems assured me, that one large blow may split even great diamonds, if it be given, as they speak, with the grain; but against the grain, he affirm'd to me, he is not able so much as to cut or polish them.

The common colour of diamonds being generally known by sight, 'tis not necessary, nor wou'd it be easie to describe it by words; but the most usual colour of these gems is not the only one. A great traveller into the eastern parts of the world assured me, that he had seen some of them that were of a pale bluish colour. That famous *French* jeweller, Monsieur *Tavernier*, gives an account of a fair diamond that he had, of a very red colour; a great lady told me, she was mistress of a fair one, which, tho' not of a ruby, was of a red colour: and a relation of mine used to wear a diamond ring; which, tho' the stone was not great, he valued at a hundred pounds, because its colour was of so fine a golden yellow, that I should have taken it for an excellent topaz. And attentively surveying a parcel of rough diamonds, newly brought from the *East-Indies*, I perceived among them, besides several lighter variations of colour, one stone, which was all green; and this to such a degree, that I doubted not, if polished and set, it might pass for an excellent emerald. I should

should have suspected this gem to have been really of that kind, NAT. HIST. but that I found it among diamonds belonging to merchants, too skillful in those gems to be impos'd upon; and, which was more, the stone being yet rough and uncut, I found it plainly to have the proper shape of a diamond.

At the late return of the ships from *India*, being present when the diamonds were delivered to their owners, I took particular notice of one belonging to a *Dutch* merchant, whose father was a cutter of diamonds, and bred him to the same trade. This diamond came from the kingdom of *Golconda*, it had six triangular sides, which yet were neither regularly figured, nor truly flat; some of them being a little convex, and one of them having a manifest, and oddly-figured cavity in it. The stone was fair and flawless, and so thick, that the merchant told me, it would be too deep for one ring, and that, therefore, he meant to split it in two: it weighed ten carrats. I could easily perceive the grain of this diamond, which the merchant also acknowledged; who said, he had never seen in diamonds any heterogeneous mixture inclosed. He further inform'd me, that he received a large diamond from *Borneo*, that was much darker than one I shewed him; so that he compared it to soot; but when cut and polish'd, he and others were much surprized, to find it a fair and clear stone, of very great value.

That the real virtues of gems, may be probably deriv'd from the metalline, or mineral tinctures, or other corpuscles that were imbody'd with the matter of the gem, whilst it was yet fluid, or soft, and afterwards coagulated therewith, appears probable; because having long suspected, that the matter whereof diamonds principally consist, was, whilst yet in *solutis principiis*, impregnated with metalline, and more particularly with ferruginous particles; and finding again, some number of small diamonds, that I had bought for experiments, I considered that their being yet rough, and so in their natural state, might make them more fit for my purpose. They were also not so clear as those that we value in rings, which, probably, argued their having more of a chalybeate tincture in them, than I should expect in the more transparent. I, therefore, took a moderately vigorous load-stone, and apply'd it successively to five or six of these small stones, without perceiving it had any operation on them: but when I came to apply it to one, which looked somewhat duller than the rest, I found that it had in it particles enow of a ferruginous nature, to make it magnetic; and observ'd that it would not only suffer it self to be taken up by the strongest pole of the load-stone, but when that pole was offer'd within a convenient distance, it would readily leap through the air to fasten it self to it.

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'Tis, on one side, taken for granted, that all glittering gems shine in the dark; and on the other, absolutely deny'd, that any stone has that faculty. For my self, I confess, I look upon Mr. Clayton's diamond as a great rarity, because of its shining by night.

*Boetius de Boot*, indeed, who is judg'd the best author upon the subject of gems, allows no such virtue in diamonds, and peremptorily says, "no man ever durst aver he had actually seen a stone that, of "it self, afforded light." *Johannes de Laet*, also, thinks no instance of it can be produced. And *Olaus Wormius* seems to imagine it falsely reported even of the carbuncle. And, indeed, upon examining a most excellent ruby, I could not, by friction, bring it to afford the least glimmering of light.

Whether gems  
are, of them-  
selves, lumi-  
nous?

But tho' I am loth to admit strange things for truth, yet I am not very forward to reject them as impossibilities; and therefore, would not discourage any from making farther inquiry, whether there be such a thing as a true carbuncle, or stone, that, without rubbing, will shine in the dark? For if such a thing can be found, it may afford no small assistance in discovering the nature of light. *Vartomannus*, indeed, was not an eye-witness of what he relates, that the king of *Pegu* had a true carbuncle, of that bigness and splendor, as to shine very gloriously in the dark; and tho' *Garcias ab Horto*, the *Indian* vice-roy's physician, speaks of another carbuncle only upon the report of one he discours'd with, who affirmed himself to have seen it; yet as we are not sure that these pretended eye-witnesses speak true, they may have done so, far ought we know to the contrary. And I could produce a much more considerable testimony to the same purpose, if I had the permission of the person. But I may say, that *Marcus Paulus Venetus*, whose supposed fables many of our later travellers and navigators have since found to be truths, speaking of the king of *Zeilan*, tells us, he is said to have the best ruby in the world, a palm long, and big as a man's arm, without spot, and shining like a fire. He adds, that the great *Cham* offer'd the value of a city for it; but the king answer'd, he would not exchange it for the treasure of the world; because it had descended to him from his ancestors. And two *Russian Cossacks* relate, in the account of their journey to *Catray*, dedicated to their emperor, that they were told, the king of those parts had a stone which gives light like the sun, both day and night, and call'd, in their language, *Sarra*; which those *Cossacks* interpret a ruby. But these relations are too uncertain to build any thing upon. However, there arriv'd here about two years since, out of *America*, the governour of one of the principal colonies there, an ancient virtuoso, and a member of the Royal Society, who, finding the chief affairs of his country committed to me and another, made me several visits, and in one of them told me, the *Indians* had a tradition, that in a certain, almost inaccessible hill, far up in the country, there was a stone, which, in the night time, shone very vividly to a great distance; and he assured me, that tho' he thought it not fit to venture

him



himself so far among those savages, yet he purposely sent a bold *Englishman* thither, with some natives for his guides; and that this messenger brought him back word, that at a distance from the hill he had plainly perceived such a shining substance as the tradition implies; and slighting the superstitious fears of the inhabitants, with great difficulty, made a shift to clamber up to that part of the hill where, by a very careful observation, he suppos'd himself to have seen the light; but whether he had mistaken the place, or for some other reason, he cou'd not find it there; tho' when he was return'd to his former station, he again perceiv'd the light in the same place where it shone before. I reserve to my self a full liberty of believing no more of this relation than I see cause; yet I the less scruple to communicate it, because it agrees, in great measure, with the following accounts. For tho' the learned authors, I formerly mentioned, think no writer has affirmed himself to have seen a real carbuncle; yet considering the light of Mr. Clayton's diamond, it recall'd to my mind, that some years before I had met with an old *Italian* book, highly extoll'd by very competent judges, the author whereof is *Benvenuto Cellini*, who has a passage in it to this purpose. "In *Clement* the 7th's time, says he, I happen'd to see a carbuncle at a certain *Ragusan* merchant's, named *Beigoio da Bona*. This was a white carbuncle of that vivid kind of paleness we see in a chalcedonian; but it had a surprizingly pleasant lustre, and shone in the dark, tho' not so much as colour'd carbuncles; however, in an exceeding dark place, I saw it shine in the manner of fire almost extinguished. But as for colour'd carbuncles, it has not been my fortune to see any. But a *Roman* gentleman of great experience in jewels told me, that one *Jacopo Cola* being, by night, in a vineyard of his, and spying something in the midst of it that shone like a little glowing coal, at the foot of a vine, he went near the place where he thought he had seen the fire; but not finding it, he said, that being returned to the same place whence he had first seen it, and perceiving there the same splendor as before, he mark'd it so carefully, that at length he came to it, and took up a very little stone, which he carried away with transport. And the next day relating to some friends after what manner he had found it, a *Venetian* ambassador, very skilful in gems, happening to be present, knew it to be a carbuncle, and therefore subtilly, before he and the said *Jacopo* parted, purchas'd it for ten crowns, and immediately left *Rome*, to avoid restoring it. He farther affirms, that this *Venetian* gentleman afterwards sold it to the grand Seignior for a hundred thousand crowns."

Here *Cellini* affirms himself to have seen a real carbuncle with his own eyes; and he appears to be very cautious in what he delivers, and is inclin'd rather to lessen, than increase the wonder of it. This testimony is the more considerable, because tho' *Cellini* was born a subject neither to the pope nor to the king of *France*, yet both those princes employed him much about their noblest jewels. What is now report-

ed

NAT. HIST. ed concerning a shining substance to be seen in one of the islands about Scotland, I leave to Sir Robert Morray, to whom the information was originally given. M. Boreel, an ingenious Dutch gentleman, whole father was long ambassador for the Netherlands in England, told me, he was acquainted with the admiral of the Dutch in the East-Indies, who assured him, that at his return from thence, he brought with him into Holland a stone, which, tho' it look'd but like a pale, dull diamond, such as Mr. Clayton's was, yet proved a real carbuncle, and did, without rubbing, shine so much, that when the admiral had occasion to open a chest, which he kept under deck, in a dark place, it would immediately, by its native light, illuminate a great part thereof. I impatiently expect a more particular account of this stone from the admiral himself, who is still alive in Holland; not only because so unlikely a thing needs a clear evidence, but because I have had some suspicion that, supposing the truth of the thing, what may be a shining stone in a very hot country, as the East-Indies, may, perhaps, cease to be so in one as cold as Holland. For in Mr. Clayton's diamond, I observed, that a very moderate degree of warmth, without friction, would make it shine a little. And, I confess, this is not the only odd suspicion my experiments upon that diamond have suggested to me. Nay, I begin to doubt whether it may not, in some cases, be true, that the right turquoise will change colour as the wearer is sick or well; and manifestly lose its splendor at his death. For when I found, that even the warmth of a friction, that lasted not above a quarter of a minute, and even that of my body, whole constitution is none of the hottest, would make a manifest change in a diamond; it seem'd not impossible, that certain warm and saline exhalations, issuing from the body of a living man, may, some way or other, by their presence or absence, diversify the colour and the splendor of so soft a stone as the turquoise\*. 'Tis so very remarkable what the judicious lapidary, Boetius de Bock affirms of this stone, that the narrative of it ought not to be omitted. "I constantly wear a turquoise in a ring, says he, the "strange property whereof I can never sufficiently admire. Thirty "years ago 'twas worn by a Spaniard, and, after his death, exposed to "sale among the rest of his goods; upon the report whereof, there "was a great concourse of such persons as had formerly admired its "beauty, and among the rest my father: but they were all surpriz'd "to find it quite sully'd and faded; whence they conjectur'd it had "been chang'd for another: my father, however, bought it for a "very small matter, but thought so meanly of it, that since, cry'd "he, 'tis a common saying, that a turquoise must be made a present "of before it will display its virtue, do you, my son, wear it; but

Whether the  
turquoise stone  
may lose its  
lustre upon the  
sickness or  
death of the  
person who  
wears it.

\* Turquoise stones are nothing but animal bones petrified, and a blue colour given them by fire. There are mines

of them in France: and a large account is given of this matter in the French Memoirs. A. 1715. p. 230.

" think-

" thinking it too mean to wear without some ornament, I caus'd it to be engraved, and made into a seal-ring; and before I had wore it a month, its lustre return'd; tho' it shone less bright on account of the graving. This rais'd wonder in us all, and the more, because it improves in beauty every day; for which reason I never lay it aside, and still continue to wear it."

This relation seems confirmed by the testimony of *Olaus Wormius*. And I my self have seen a turquoise, worn in a ring, wherein there were some small spots, which the person who owned it assured me, he had observ'd to grow sometimes greater, sometimes less; and to be sometimes in one part of the stone, sometimes in another. I desired him to take pictures from time to time of the stone, and of the situation of the cloudy parts, that their motion might thence be more indisputable, and the better observ'd; he afterwards assured me, he had thus drawn schemes, whereby the several removes and motions of the clouds are very manifest; tho' the cause seem'd to him very obscure. These pictures he has promis'd to shew me, and is very ready to put the stone it self into my hands; but the ring having since been casually broken upon his finger, unless the stone can be taken out, and set again without any considerable heat, he is unwilling to have it meddled with, for fear its peculiarity should be thereby destroyed. And, possibly, his apprehension would have been strengthened, if I had told him what is related by the learned *Wormius*, of an acquaintance of his, who had a nephritic stone, the eminent virtues whereof he often experienced; and for that reason wore it still about his wrist. But going into a bath of water wherein certain herbs had been boiled, the stone, by being wetted with the decoction, was deprived of all its virtue. And we might expect to find turquoises, likewise, easie to be wrought upon in point of colour, if it be true, which the curious *Antonio Neri* says; that when discoloured and grown white, they will again acquire an excellent colour, if kept two or three days cover'd with oil of sweet almonds, standing in warm ashes. But I could not satisfy myself herein, because the most skilful persons, among whom I have enquired for turquoises, assure me, that the true ones are great rarities. 'Tis, however, remarkable, that the stone called *Oculus mundi*, if it be good in its kind, will have so great a change made in its texture, by being barely left a while in common water, that from opaque, it becomes transparent; and acquires a lustre, of which it will be again deprived, without any art or violence, by leaving it a while in the air. But before experience had satisfied us of the truth hereof, it seem'd as unlikely, that common water, or air, should work such great changes in that gem, as now that the effluvia of a human body should produce less changes in a turquoise.

But to come to the observations we made on Mr. Clayton's diamond.

12. This



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*Observations  
upon a dia-  
mond that  
would shine re-  
markably, in  
the dark.*

1. This was a table diamond, about a third of an inch in length, and somewhat less in breadth; a dull stone, of a very bad water; having in the day time very little of the vividness of ordinary diamonds, and being blemished with a whitish cloud about the middle, which covered near a third of the stone. 2. Nothing remarkable appeared in any part of it, when examined with a microscope; but view'd in the day time, in a bed, with the curtains carefully drawn, I could not discern it to shine at all, tho' well rubb'd; but about a little after sun-set, whilst the twilight yet lasted; and in the morning, a pretty while after sun-rising, I could, after a light friction, easily perceive it to shine. 3. The candles being remov'd, I could not, in a dark place, discern the stone to have any light when I looked on it, without having rubb'd, or otherwise prepared it. 4. Neither by two white pebbles, hard rubb'd one against the other, by the long and vehement friction of rock crystal, against a piece of red cloth; nor by rubbing two diamonds set in rings, as I had rubb'd this stone, could I produce any sensible degree of light. 5. I found this diamond hard enough not only to write readily upon glass, but to grave on rock-crystal it self. 6. I found this to have, like other diamonds, an electrical virtue; for it wou'd attract light bodies, as amber, jet, &c. tho' in a less degree. 7. Being rubb'd upon my cloaths, as is usual, to excite amber, wax, and other electrical bodies; it did, in the dark, manifestly shine like rotten wood, the scales of whittings, or other putrefied fish. 8. But this light was fainter than that of the scales and slime of whittings, and much fainter than the light of a glow-worm; by which I have sometimes been able to read a short word; but after an ordinary friction of this diamond, I cou'd not distinctly discern any of the nearest bodies by the light of it. This glimmering, also, very considerably decay'd, immediately upon ceasing the friction; tho' the stone continued visible for some time after. 9. But if it were briskly rubb'd upon a convenient body for a pretty while, I found the light would be, for some moments, much more considerable, almost like the light of a glow-worm; so that, after I had ceas'd rubbing, I cou'd, with the chafed stone, exhibit a little luminous circle, faintly resembling that made by the motion of a stick fired at one end; and thus it wou'd continue visible, about seven or eight times as long as the preceding friction lasted. 10. I found, that holding it a while near the flame of a candle, with my eyes turn'd a contrary way, and immediately removing it into the dark, it disclos'd some faint glimmering, but inferior to that acquired by rubbing. And afterwards holding it near a fire, that had but little flame, it was rather less excited thereby, than by a candle. 11. I, likewise, endeavoured to make it shine, by holding it for a pretty while in a very dark place, over a thick piece of iron, that was well heated, but not to that degree as to be visible. And tho' at length I found the stone hence acquired some glimmering,  
yet

yet it was less than it gain'd by either of the other ways just mentioned. 12. I also brought it to some glimmering kind of light, by taking it into bed, and holding it a good while upon a warm part of my naked body. 13. To satisfy my self, whether the motion introduced into the stone, generated the light upon account of its producing heat there; I held it near the flame of a candle, till it was qualified to shine pretty well in the dark; and then immediately apply'd a slender hair, to try whether it would attract it; but found not that it did. And for further confirmation, I once purposely kept it so near the hot iron, lately mentioned, as to make it sensibly warm; yet it shone more dimly than it had done by means of friction, or the flame of a candle; tho' by both those ways it acquired not any sensible warmth. 14. Having purposely rubb'd it upon several bodies, different both in colour and in texture, there seemed to be some little difference in the excitation of the light. Upon white and red cloth it seemed to succeed best, especially in comparison of black. 15. But to try what it would do when rubb'd upon bodies more hard, and less apt to afford heat upon a light friction, than cloth, I first chafed it upon a white wooden box, by which it was excited; and afterwards upon a piece of earth purely glaz'd; which seemed, during the attrition, to make it shine better than any of the other bodies, without excepting the white ones; so that the effect cannot be ascribed to the greater disposition white bodies have to reflect light. 16. Having well excited the stone, I suddenly plung'd it under water, provided for that purpose; and perceived it to shine whilst it was beneath the surface of the liquor; and this I did several times. But when I endeavoured to produce a light, by rubbing it upon the box lately mentioned, while both the stone and it were held beneath the surface of the water, I did not well satisfy my self in the event of the trial: but this I found, that if I took the stone out, and rubb'd it upon a piece of cloth, it would, as usual, presently yield a light; tho' it required to be rubb'd much longer, before the desired effect was produced. We likewise plung'd it, after we had excited it, in liquors of several sorts, as spirit of wine, oil, both chymical and express'd, an acid spirit, and an alkaline solution; but found not any of those various liquors to destroy its shining property. 17. I also several times try'd, that by covering it with spittle, it did not lose its light. And having found by this observation, that a warm liquor would not extinguish light in the diamond, I thought fit to try, whether, by reason of its warmth, it would not excite it; and found, that if it were kept in warm water, till that had communicated its heat thereto, it would frequently shine as soon as taken out; and, probably, we should have seen it shine more, whilst it remained in the water, if some degree of opacity, which heated water acquires, upon account of the numerous little bubbles generated in it, had not kept us from discerning

NAT. HIST. the lustre of the stone. 18. Finding that by rubbing the stone with the flat side downwards, I lost, by reason of the opacity of the ring, and the sudden decay of light, upon the cessation of the attrition, the sight of the stones greatest vividness; and supposing that the commotion made in one part of the stone, would be easily propagated all over, I sometimes held the piece of cloth, upon which I rubb'd it, so, that one side of the stone was expos'd to my eye, whilst I chafed the other; whereby it appeared more vivid than formerly, and to make luminous tracts by its motions backward and forward. And, sometimes, holding the stone upwards, I rubb'd its broad side with a fine smooth piece of transparent horn; by which means the light thro' that diaphanous substance appeared so brisk, whilst I was actually rubbing the stone, that sometimes, in some places, it seem'd to give little sparks of fire. 19. I took also a piece of flat, blue glass, and having rubb'd the diamond well upon a cloth, and suddenly covered it with that glass, to try whether, in case the light could penetrate thro', it would, by appearing green, or of some other colour than blue, assist me to guess, whether it were simple or no. But finding the glass impervious to so faint a light, I thought fit to try, whether hard bodies would not, by attrition, assist the diamond's light, so as to become penetrable thereby. And, accordingly, when I rubb'd the glass briskly upon the stone, I found the light to be conspicuous, and somewhat dyed in its passage; but could not easily give a name to the colour it exhibited. 20. Lastly, suspecting, upon the whole, that the principal, manifest change wrought in the stone, was by a compressure of its parts, rather than a heat; I found, that if I press'd the stone hard against a piece of white, well-glaz'd tile, it seem'd, tho' I did not rub it, to shine at the sides; but it shone very manifestly and vigorously, if, whilst I thus press'd, I moved it any way upon the surface of the tile; tho' it drew not a line above a quarter of an inch long thereon; and tho' I only made it move from one end of that short line to the other, without any return, or lateral motion: nay, after it had been often rubb'd, and suffered to lose its light again, it not only seem'd more easie to be excited than at first; but if I press'd hard upon it with my finger, at the very instant that I drew it briskly off the stone, it would give a very vivid, but exceeding short-liv'd splendor or little coruscation. And pressing the point of a steel bodkin, hard against the surface of the diamond, but much more if I struck the point against it, the coruscation would be extremely sudden, and very vivid, tho' very vanishing too; and this way, which commonly greatly surprized and delighted the spectators, seem'd far more proper than the other, to shew that pressure alone, if forcible enough, tho' it were so sudden and short, that it could not well be suppos'd to give the stone any thing near so sensible a degree



degree of warmth, as may be suspected in friction, is yet sufficient to generate a very vivid light.

So many particulars observ'd in one night, may make this stone appear a kind of prodigy; but upon further trial with my own diamonds, by means of such a brisk and assiduous friction, as might ballance the disadvantages under which they laboured, in comparison of Mr. Clayton's, I found that I could easily bring a diamond I wore on my finger, to yield a sensible light; and it continued so to do, tho' I covered it with spittle, and used some other means of examination.

We afterwards tried rubies, sapphires, emeralds, &c. but found none of them to shine, except some diamonds; and of these we were not able to say beforehand, which would be brought to shine, and which would not; for several very good diamonds would either give no light at all, or much less than others, that were far inferior to them. And yet 'tis a mistake to think, a diamond must be foul and cloudy, as Mr. Clayton's was, to shine; for as we could bring some such to afford a glimmering light, so some clear and excellent diamonds did the like. But none of those many that we try'd of all kinds, were equal to Mr. Clayton's; not only for the degree of light it afforded, but the easiness wherewith it was excited, and the comparatively great duration of its splendor.

And this may lessen our wonder at the preceding observations, by shewing, that such strange properties are not peculiar to one diamond, but may be found in others also, and perhaps in several hard diaphanous stones\*. But what this discovery takes off from the surprize of these phenomena, I hope it will add to the usefulness of them, in discovering the nature of light. To which purpose we will here add some other experiments and observations.

X 2

I. Oct.

\* " By rubbing a well-polished piece  
" of amber, (saith Dr. Wall,) with my  
" hand, in the dark, it produced a  
" light; and drawing a long taper piece  
" of it thro' a woollen cloth, and  
" squeezing it hard, a prodigious num-  
" ber of little cracklings were heard;  
" and every one of those produced a  
" little flash of light; and if the amber  
" was only drawn gently thro' the cloth,  
" it produced a light, but no crackling;  
" and the light, upon its eruption, strikes  
" the finger very sensibly, if held near  
" it, with a puff, like wind." The Dr.  
" adds, " that the best time of making  
" the experiment is, when the sun is  
" 18° below the horizon; when, tho'  
" the moon shines ever so bright, the  
" light is the same as in the darkest  
" room. And as diamonds (continues

" the same ingenious gentleman,) are  
" electrical as well as amber; I have  
" made some trials upon them, and think  
" my way of distinguishing diamonds  
" morally certain. A diamond, by an  
" easy slight friction in the dark with  
" the finger, woollen, or any soft animal  
" substance, appears in its whole body  
" to be luminous; nay, if you keep  
" rubbing for a while, and then expose  
" the stone to the eye, 'twill continue lu-  
" minous for some little time. But if  
" while the the sun is 18° degrees below  
" the horizon, any one holds up a piece  
" of flannel stretched tight, at some di-  
" stance from the eye; and another  
" briskly rubs the flannel hard with a  
" diamond on the other side; the light  
" to the eye of him who holds it, seems  
" much

NAT. HIST.

The light of  
rotten wood  
extinguished  
in vacuo.

1. *Octob. 29. 1667.* Having procured a piece of shining wood, about the bigness of a groat or less, that gave a vivid light; we put it into a middle-sized receiver, so that it was kept from touching the cement; and the pump being set a-work, we observed not, during the first five or six exsuctions of the air, that the splendor of the included wood was manifestly lessened; though it was never at all increased; but about the seventh suck, it seem'd to grow a little more dim, and afterwards answered our expectation by losing of its light more and more, as the air was pumped out; till about the tenth exsuction (tho' by the removal of the candles out of the room, and by black cloaths; &c. we made the place as dark as possible) we could not perceive any light at all to proceed from the wood.

2. Wherefore we let in the outward air, by degrees; and had the pleasure to see the seemingly extinguish'd light revive so fast and perfectly, that it looked almost like a little flash of lightning, and the splendor of the wood seem'd rather greater, than before it was put into the receiver.

But for greater certainty, and to enjoy so delightful a spectacle, we repeated the experiment with the like success as at first. Wherefore being desirous to see how soon these changes might be produced, we included the wood into a very small receiver of clear glass, and found, that in this the light would begin to grow faint at the second, or at least at the third exsuction of the air, and at the 6th or 7th quite disappear. And we found, by a minute-watch, that the sending the candles out of the room, the pumping out the air till the wood would shine no more, the re-admitting of the air (upon which it would in a trice recover its light) and the sending in for the candles to consult the watch, did in all take up but six minutes.

3. Having exhausted this new receiver, till the wood quite disappeared, we stay'd somewhat above a quarter of an hour in the dark, without perceiving that it had regained any thing of light; though about the end of this time, we made the place about it as dark as we could; and then (it being too late at night to protract the experiment,) we let in the air, upon whose admission the wood

"much more pleasant and perfect than  
"in any other way I have yet tried. But  
"what is still more strange, a diamond  
"being exposed in the open air to the  
"sky, gives almost the same light with-  
"out rubbing; as if rubbed in a dark  
"room; and if in the open air you any  
"way hinder its communication with  
"the sky, it yields no light. I have tri-  
"ed all or most of the other precious  
"stones, but could find no such pheno-

"menon in any of them. My experi-  
"ments were made at the latter end of  
"May, and the beginning of June; so that  
"I pretend not to account for the pheno-  
"mena of experiments made when the  
"sun is on the other side of the equator.  
"— I am well assured, that all, or most  
"of the bodies which have an electricity,  
"yield light by friction." See *Philos.*  
*Transf. No. 314.*

pre-

presently recovered light enough to be conspicuous at a distance, tho' it seemed to me somewhat less vivid than before; which yet may be owing either to a weakness in my sight, or an effect of the steams of the cement, unfriendly, perhaps, to the luminousness of the wood.

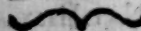
The night following we put in a piece of wood bigger than the former, being above an inch long, and this shone very vigorously; and having by a few sucks quite deprived it of light, we left it in the exhausted receiver for full half an hour; and then coming into the dark room again, we found all had not continued so stanch, but that some air had insinuated it self into the receiver. This we concluded to be but a small portion of air, because the wood was barely visible to an attentive eye: and yet, that it was really some air got in, that caused the little glimmering light we perceived, may appear by this, that it presently vanish'd at the first or second suck; and then the air being let into the dark receiver, the included wood presently shone again, as before; tho' I suspected that I discerned some little diminution of its brightness; which yet, 'till further trials of the like kind, and for a longer time, have been made, I dare not affirm.

4. Having observed, on another occasion, that sometimes the operation, which the withdrawing of the air hath upon a body included in the receiver, proves more considerable some minutes after we ceased pumping, than immediately upon leaving off that exercise; I imagined, that even in such cases, where the light is not made wholly to disappear by the emptying of the pneumatical glass, the suffering the body to remain a while there, tho' without any pumping (unless now and then a very little to remove the air, that might have insinuated in the mean time) the remaining light of the body might, probably, be further impaired, if not reduced quite to vanish. To examine this conjecture, we put in a body that was not wood, which had some parts much more luminous than the rest; and having drawn out the air, all the others disappeared, and even the formerly brighter ones shone but faintly, when the pneumatical glass seemed to be exhausted. But keeping the included body a while in that unfriendly place, we perceived the parts that had retained light, to grow more and more dim, some of them disappearing, and that which was formerly the most conspicuous, being now but just visible to an attentive eye, and that scarce without dispute; for if we had not known beforehand, that a shining matter had been included in the receiver, perhaps we should not have found it out. And he who had the youngest eyes in the company, could not at all discern it; but the air being let in, the body began to shine again.

5. The rarification, or expansion of the air, having so notable an operation upon our shining wood, I thought it would not be amiss to try, what the compression of the air would do to it: For which purpose we included a piece of it in such a little instrument, or

con-



NAT. HIST.  condenfor, as was devised and proposed by Mr. *Hook*. But tho' we impell'd the air forcibly into the glass, yet by reason of the thickness requisite in such glasses, and the opacity thence arising, we were not able to determine, whether any change was made in the luminousness of the wood. Which I thought the less strange, because, by some experiments purposely devised, I had long since observed, that even a great pressure from a fluid body, which presseth more uniformly against all the parts it toucheth of the consistent body, works a far less manifest change, even on soft or tender substances, than one would expect from the force wherewith it compresseth.

6. Thinking fit to try, whether a small quantity of air, without being ventilated or renewed, might not suffice to maintain this cold fire, though it will not that of a live coal, or a piece of match; we caused a piece of shining wood to be hermetically sealed up in a pipe of clear and thin glass; but though carrying it into the dark, we found it had quite lost its light, yet imagining that this might proceed from its having been over-heated (being sealed up in a pipe not long enough to afford it a due distance from the flame of the lamp we employed to seal it) we caused two or three pieces of fresh wood, amounting, all of them, to the length of about two inches, to be sealed up in a slender pipe, between four or five inches long; which being warily done, the wood retained its light very well, when the operation was over; and afterwards laying it by my bed-side, when the candles were carried out of the room, I considered it a while before I went to sleep, and found it to shine vividly.

The next morning when I awaked, though the sun was risen, yet forbearing to draw open the curtains of my bed, till I had looked upon the sealed glass, which I had fenced with a piece of cloth held between it and the window; my eyes having not yet been exposed to the day-light, since the darkness they were accustomed to during the night, made me think the wood shone brighter than ever. And at night, after ten of the clock, looking on it in a dark place, it appeared luminous in all its length, though not so much as in the morning.

The morning after, and the night after that, the same wood did likewise manifestly, though not vigorously, shine; especially one piece, whose light was much more vivid than the rest: and, for ought I know, I might have observed them to shine longer, if one of the sealed ends of the glass had not been accidentally broken.

7. I caused a piece of iron to be forged, whose top was of the bigness of a nutmeg; the rest being a stem, of an inch, or an inch and a half long, for which we provided a little candlestick of tobacco-pipe clay, that would not yield any smoak to fill and darken the receiver. Then having heated the iron red-hot, and placed it in this clay,

clay, so that the round part was clearly protuberant, we conveyed it into a receiver of white glass, which was so placed, as to keep the sides at as great a distance as we could from the iron, lest the excessive heat should (as we much feared it would) break the glass. Then sending away the candles, and making the room dark, we hastily pumped out the air; but could not perceive the withdrawing of it had any operation on the glowing iron. And though it continued shining long enough, to give us an opportunity to pump out, and let in the air, three several times; yet we could not observe, that the air had any manifest operation one way or other: for though, upon the withdrawing thereof, the iron grew dimmer and dimmer, yet that I attributed to the cooling of it; and the rather, because having (to examine the conjecture) let in the air two or three times, when the receiver had been exhausted, there appeared no manifest increase of light upon the sudden admission of it.

8. Some curious persons would, perhaps, if they had been present, have desired to see, whether a small piece of shining wood, being so included in the receiver, that the pumping out of the air should have no injurious operation upon the substance, its light would, upon the withdrawing of the air, be manifestly diminished. This I was the less backward to try, because it did not readily occur to me, that by any manifest experiment it appeared, that a body more thin than air, will, or can transmit light, as well as other diaphanous mediums. Wherefore having hermetically sealed up a piece of shining wood in a slender pipe, and placed it in a small receiver, that was likewise made of clear glass, we exhausted it of air, and afterwards let in again that which we had excluded. But by neither of the operations could we perceive any sensible decrease, or increase, of the light of the wood; though by that very observation it appeared, that the glass had been well sealed, since otherwise the included air would have got out of the pipe into the receiver, and have left the wood without light.

9. I took an old, thin glass, sealed at one end, whose shape was pretty cylindrical, whose bore was about the bigness of a man's little finger, and whose length was about a foot or more. Into this pipe, near the sealed end, we put a piece of shining wood, wedged in with a piece of cork, to keep it from falling; and having inverted the nose of it into another slender glass, but not cylindrical, wherein was pretty store of quick-silver; we put them both into a long receiver, shaped almost like a glass churn, and having pumped a while, that the air included in the pipe expanding it self, might depress the quick-silver, and so make escapes into the receiver as long as we thought fit; we then let in the outward air, that the stagnant quick-silver might be impelled into the cavity of the pipe, now freed from much of the air, to the height requisite for our purpose.

This

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This done, we plied the pump again, and observed, that as the air in the pipe did, by its own spring, expand it self more and more, and grow thinner and thinner, the shining wood grew dimmer and dimmer, till at length it ceased to shine; the internal air being then got much lower than the surface of the external quick-silver; whereupon opening the commerce between the cavity of the receiver, and the atmosphere, the quick-silver was driven up again, and consequently the air above it was restored to its former density; upon which the rotten wood also recovered its light. What the greatest expansion of this air was, we could not certainly determine, because it raised the external quick-silver so high, as to hinder us from seeing and measuring it: but we guessed, that the air reached to about a foot or more, from the top of the pipe, to the surface of the quick-silver, near the bottom thereof. But when that rarified air was impelled into its former dimensions, we measured it, and found, that the upper part of the tube, unpossess'd by the quick-silver, was about three inches; and the wood being about an inch long, there remained two inches, or somewhat better, for the air. But this experiment ought to be repeated, when exacter instruments can be procured.

*Shining fish  
in vacuo.*

10. Thinking it fit to try, as well, whether putrid fish that shines, be of the same nature, as to luminousness, with rotten wood that shines too; as, whether the withdrawing of the air will extinguish or eclipse the light of a considerable bulk of luminous matter, as in the experiments hitherto made, we found it would do to a small one: we took a fish, that we had kept, and caus'd to be watched, till it was almost all over luminous; though much more in the belly, and some parts of the head, than elsewhere; and having suspended it in a conveniently shaped receiver, we found it to give so great a light, that we suspected before hand, that the withdrawing of the air would hardly have its full operation upon a body, whose bulk was considerable, as well as its light very vivid, and which had many luminous parts retired to a pretty distance from the air. Accordingly, having exhausted the receiver, as much as usual, it appear'd indeed, especially towards the latter end of the operation, that the absence of the air did considerably lessen, and in some places eclipse, the light of those parts that shone less strongly: but the belly appeared not much less luminous than before. Wherefore supposing, that upon turning of the stop-cock, the air coming in much more hastily than it could be drawn out, we should have the best advantage to discern, what interest it had in the luminousness of the fish, we re-admitted it; and upon its rushing in, perceived the light to be, as it were, revived and increased; those parts of the fish that were scarce visible before, or shone but dimly, recovering presently their former splendor.

And



And not to leave unprosecuted the remaining part of the experiment, which was to try, whether the kind of the luminous body, or only the greatness of the bulk, and the vividness of light, and, if I may so speak, the tenacity of the substance it resided in, made the difference between the fish and the wood; we put part of the fish of another kind, that shone much more faintly than that hitherto spoken of, and but in some places; and by the withdrawing the air, we made some of the luminous parts disappear, and the others so dim, as scarce to be discerned; and yet both the one and the other regained their former light upon the return of the air.

And to pursue the experiment a little further, we put in such a piece of the first fish, as though it were bright, was yet but thin, and not considerably broad; and upon pumping out the air, we found it, according to our expectation, quite-eclipsed, though it recovered its light upon the air's re-entry.

'Tis probable, that some will make use of this discovery to countenance their opinion, that notwithstanding the coldness (at least as to sense) of fishes, and other animals, there may be in the heart and blood a vital kind of fire, that needs air, as well as those fires which are sensibly hot: which may lessen the wonder, that animals should not be able to live when robb'd of air.

11. To examine the conjecture mentioned in the last experiment, that the durableness of the light in the shining fish, in spite of the withdrawing the air, might proceed in great part from the vividness of it, and the tenacity of the matter it resided in, rather than from the extent of the luminous body, in comparison of the small pieces of shining wood, I had hitherto made my trials with; in Dec. 1667. I got a large piece of wood, whose luminous superficies might be, perhaps, ten or twelve times as great as that, which the eye saw, at once, of the surface of such fragments of shining wood, as I used to employ. And though some parts of this large superficies shone vividly enough for rotten wood, (for the light was usually inferior to that of our fish) yet this great piece being put into a convenient receiver, was, upon the withdrawing of the air, deprived of light, as the smaller ones had been formerly; the returning air restoring its light to the one, as it had done to the other.

12. I took some small pieces of rotten fish, that shone some of them more faintly, and some of them more vividly than one another, but none so strongly as some that I could have employed; and having in a very small and clear receiver so far drawn away the air, as to make the included bodies disappear, we so ordered the matter, that we kept out the air for about 24 hours; and then allowing it to re-enter, in a dark place and late at night, upon its first admittance they regained their light.

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13. This, compared with some of my former observations about putrefaction, put me upon a trial, which, though it miscarried, I shall here make mention of, that in case those, who are better furnished with glasses, think it worth while, they may repeat it. Considering how great an interest putrefaction hath in the shining of fishes, and air in the phenomena of putrefaction, I thought it might be somewhat to the purpose, to take a fish, that was, according to the common course I had observed in animals, not far from the state, at which it would begin to shine; and having cut out a piece of it, I caused the rest to be hung up again in a cellar, and the piece to be put into a small and transparent receiver, that we might observe, if in a day or two, or more, after the fish in the cellar should begin to shine, that in the exhausted receiver would also shine; or, because that seem'd not likely, would, notwithstanding the check which the absence of the air might be presumed to give the putrefaction, be found to shine too, either immediately upon the admission of the air, or not long after.

But this experiment was only designed and attempted, not completed; the receiver being so thin, that upon the exhaustion of the internal air, the weight of the external broke it; and we could ill spare another of that kind from trials, we were more concern'd to make: notwithstanding which, we made one trial more, which succeeded no better than the former, but miscarried upon a quite differing account, *viz.* because neither the included piece of fish, nor the remaining, though it were of the same sort with the fishes I usually employed, would shine at all, though kept a pretty while beyond the time, at which such fishes usually grew luminous.

And I will not undertake, that all the experiments another shall make with rotten fish, shall have just the same success with these I have related. For, as I elsewhere observe, that the event of other experiments is not always certain; so I have had occasion to observe the like about the shining of fishes. And I remember, that having once designed to make observations about the light of rotten fishes, and having, in order thereto, caus'd a competent number of them to be bought, not one of them all would shine; though they were bought by the same person I used to employ, and hung up in the same place, where I used to have them put; and kept not only till they began to putrefy, but beyond the time whereat others used to continue to shine; yet a parcel of the same kind of fishes, bought the week before, and another of the same kind, bought not many days after, shone according to expectation. What the reason of this disappointment was, I could not determine; only I remember, that at the time it happened, the weather was variable, and not without some days of frost and snow.

Notice must also be taken in making experiments with shining fish, that their luminousness seldom continues very many days. This advertisement may be therefore useful, because without it we may be apt sometimes to make trials, that cannot be soon enough brought to an issue; and so we may mistake the loss of light in the fish, to be a deprivation of it caused by the experiment; which indeed is but a cessation according to the usual course of nature.

14. We put a piece of shining fish into a wide-mouthed glass, about half filled with fair water, and having placed this glass in a receiver, we exhausted the air for a good while; to observe, when the pressure of the air was removed, and yet (by reason of the water that before kept the air from immediately touching the fish) the exhaustion of the receiver did not deprive the fish of that contact of air, which it had lost before; whether, in this case the absence of the air would have the same influence on the shining body, as in the former experiments.

And here, as far as the numerous bubbles excited in the water would give us leave to discern it, we could not perceive, that either the absence or return of the air, had any great operation upon the light of the immersed body.

I shall further add, that though, when I formerly put together some notes about luminous bodies, I confined not my observations to one or two sorts of fishes, yet these experiments were all of them (except a collateral one or two) made with whittings; which, among the fishes, I have had occasion to take notice of, are (except one sort that I cannot procure) the fittest for such trials.

15. To prosecute the 1<sup>st</sup> and 9<sup>th</sup> experiments in one trial, we took, somewhat late at night, a piece of rotten fish, which we judged to shine too strongly to be quickly deprived of all its light; and having put it into a small and clear receiver, we found, that the light was much impaired, but nothing near suppressed by withdrawing the air. Wherefore, having removed the receiver into a convenient place, I caused it to be brought to me about midnight; and having made the place pretty dark, I perceived the included body to continue to shine more vividly than one would have expected; and, if I mistake not, I saw it shining in the morning whilst it was dark; but the night after, coming to look upon it again, its light appeared no more. Notwithstanding which, I made a shift to keep out the air about 24 hours longer; and so, after 48 hours in all, we opened the receiver in a dark place; and presently, upon the ingress of the air, were pleasingly saluted with so vivid an apparition of light, that the included body continued to shine, when carried into a room, where there burnt both fire and candle, if it were, but by a hat, screen'd from the beams.



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Being encouraged, as well as pleased with this success, we forthwith exhausted the air once more out of the same receiver; and having kept it about four hours longer, we looked upon it again in a dark place; and finding no appearance of light, let the air in upon it, whereby it was made to shine again, and that vigorously enough.

The suddenness, with which the included body appeared to be, as 'twere, re-kindled upon the first contact of the air, revived in me some suspicions I have had, about the possible causes of those short-liv'd apparitions of light (I speak not now of real lamps found in tombs) which disclosing themselves upon mens coming in, and consequently letting fresh air into the vaults, that had been very long kept close, did soon after vanish.

These thoughts, as I was saying, occurred to me upon what I have been relating, by reason of the sudden operation of the fresh air, on a body, that but a minute before disclosed no light. For though the lights reported to have been seen in caves, quickly disappeared, which that of our fish did not; yet that difference might possibly proceed from the tenacity, or some other disposition of the matter, wherein the luminousness of the fish resides: for I remember, that I have more than once observed a certain glimmering, and small sparks of light to be produced in a sort of bodies, upon putting them out of their former rest, and taking them into the air; which sparks would vanish of themselves, sometimes within one minute, and sometimes within a few minutes. But as these thoughts were only transient conjectures, so I shall not insist any longer upon them; but rather contenting my self with the hint already given, take notice of what may be more certainly deduced from our experiment; which is, that the air may have a much greater interest in many odd phenomena of nature, than we are hitherto aware of.

And, for confirmation of our experiment, I shall add, that having, in another receiver, eclipsed a piece of fish, that shone when 'twas put in more languidly than several others that we had tried, I kept it about three days and three nights in a receiver; after which, I opened it in the dark, and upon letting in the air upon this body, that shone but faintly at first, it immediately recovered its so long suppressed light. And having included another piece that was yet more faint than that, when put into the receiver, and having kept this piece also three days and three nights in the exhausted glass, I let in the air upon it; and notwithstanding the darkness of the place, nothing of light was thereupon revived. But this being little other than I expected, from a body that shone so faintly, when 'twas put into the receiver, and had been kept there so long; I resolved to try, whether the appulse and contact of the air, would have that operation after some time, that it had not at first; and accordingly, after having waited a while, I observed the fish to disclose a light, which, though but dim, was yet manifest enough.

I shall

I shall only add, that having included in small receivers two pieces of rotten whittings, whereof the one, before it was put in, scarce shone so vividly as did the other after the receiver was exhausted; and having ordered the matter so, that we were able to keep out the air for some days; at the end of about forty eight hours, we found, that the more strongly shining body retained yet a deal of light; but afterwards looking upon them both in a dark place, we could not perceive in either any show of light. Wherefore having let the air into that receiver, wherein the body, that at first shone the faintest, had been put, there did not ensue any glimmering of light for a pretty while: nay, upon the rushing of the air into the other glass, the body that at first shone so strongly, and that continued to shine so long, shewed no glimmering of light. But within less than the quarter of an hour, we saw a manifest light in the body last named, and a while after, the other also became visible, but by a very dim light. The more luminous of these bodies I observed to retain some light twenty four hours after; and the experiment had this peculiar instance in it, that the two receivers were uninterruptedly kept exhausted no less than four days, and as many nights.

The things, wherein I observed a piece of shining wood and a burning coal to agree or resemble each other, are principally these five.

*The light of rotten wood compared with that of a glowing coal.*

1. Both of them are luminaries, that is, give light, as having it (if I may so speak) residing in them; and not like looking-glasses or white bodies, which are conspicuous only by the incident beams of the sun, or some other luminous body, which they reflect.

This is evident, because both shining wood and a burning coal, shine the more vividly, as the place wherein they are put is made the darker, by the careful exclusion of the adventitious light.

2. Both shining wood and a burning coal need the presence of the air, (and that too of a certain density,) to make them continue shining.

This has been prov'd as to a coal, by what I published in my *Physico-Mechanical Experiments*: and as to the shining wood, the experiments lately recited, make it needless for me to add any other proof of the requisiteness, not only of air, but of air of such a thickness, to make its light continue.

3. Both shining wood and a burning coal, having been deprived, for a time, of their light, by the withdrawing of the contiguous air, may presently recover it, by letting in fresh air upon them.

Particular tryals have often shewn the former part of this proposition to be true, as when kindled coals, that seem to be extinguish'd in our exhausted receivers; are presently revived, the air being restored to them: and the latter part is abundantly manifest by the experiments above mentioned.

4. Both a quick coal and shining wood will be easily quenched by water, and many other liquors.

The

NAT. HIST. The truth of this, as to coals, is too obvious to need a proof, and therefore I shall confirm it only as to wood; for which purpose, take the following transcript of some of my notes about light.

I took a piece of shining wood, and having wetted it with a little common water in a clear glass, it presently lost all its light.

The like experiment I tried with strong spirit of salt, and also with a weak spirit of sal-armoniac; but in both, the light did upon the wood's imbibing the liquor, presently disappear.

I made the like tryal with rectified oil of turpentine, with like success. The same experiment I tried more than once with high rectified spirit of wine, which immediately destroy'd all the light of the wood that was immersed in it; and having put a little of that liquor with my finger upon a part of the whole piece of wood that shone very vigorously, it quickly, as it were, quench'd the coal as far as the liquor reached; nor did it in a pretty while, if at all, regain its luminousness.

5. As a quick-coal is not to be extinguish'd by the coldness of the air, when that is greater than ordinary; so neither is a piece of shining wood to be deprived of its light by the same quality of the air.

As much of this observation as concerns the coal, will be readily granted; and for proof of the other part of it, the following trial may suffice.

I took a small piece of shining wood, and put it into a slender glass-pipe, sealed at one end, but open at the other, and placed this pipe in a glass-vessel, where I caused to be put a strongly frigorific mixture of ice and salt; but having kept it there full as long as would be requisite to freeze an aqueous body, I afterwards took it out, and perceived not any sensible diminution of its light. But tho' the light of shining fish be usually (as far as I have observed) more vigorous and durable than that of shining wood; yet I cannot say, that it will hold out against cold so well as the other: for having ordered one of my servants to cut off a good large piece of a luminous whiting, and bury it in ice and salt; when I called for it in less than half an hour after, I found it much stiffened by the cold, and to have no light, that I could discern in a dark place. And for fear that this effect might have proceeded not barely from the operation of the cold, but also from that of the salt, I caused at another time, a piece of whiting to be put in a pipe of glass, sealed at one end, and having seen it shine there, I looked upon it again, after it had stayed but a quarter of an hour, by my estimate, in a frigorific mixture, which the glass kept from touching the fish; and yet I could not perceive, in a dark place, that it retained any light.

1. The first difference I observed betwixt a live coal and shining wood is, that whereas the light of the former is readily extinguishable by compression (as is obvious in the practice of suddenly extinguishing a piece



piece of coal by treading upon it) I could not find that such a compression as I could conveniently give without losing sight of its operation, would put out, or much injure the light, even of small fragments of shining wood. One of my tryals about this I find thus set down.

I took a piece of shining wood, and having pressed it between two pieces of clear glass (whereof the one was pretty flat, and the other convex) so that I could clearly see the wood through the glass, I could not perceive, that the compression, tho' it sometimes broke the wood into several fragments, did either destroy, or considerably alter the light.

2. The next difference to be taken notice of betwixt rotten wood and a kindled coal is, that the latter will, in a very few minutes, be totally extinguish'd by withdrawing the air; whereas a piece of shining wood, being eclipsed by the absence of the air, and kept so for a time, will immediately recover its light, if the air be let in upon it again within half an hour after it was first withdrawn.

The former part of this observation is easily proved by the experiments that have been often made upon quick coals in the pneumatical engine; and the truth of the latter part appears by the experiments about shining wood, mentioned above. Neither is it improbable, that, if I had conveniency to try it, I shou'd have found that a piece of shining wood, deprived of its light by the removal of the ambient air, would retain a disposition to recover it upon the return of the air, not only for half an hour, but for half a day, and perhaps a longer time.

3. The next difference to be mentioned is, that a live coal being put into a small close glass, will not continue to burn for very many minutes; but a piece of shining wood will continue to shine for some whole days.

The first part of the assertion, I know will be readily granted; and the other part of it may be easily made out by what I have tried upon shining wood, sealed up hermetically in very small glasses, where the wood did, for several days, retain its light.

4. A fourth difference may be this: that whereas a coal, as it burns, sends forth store of smoke or exhalations; luminous wood does not.

5. A fifth, flowing from the former is, that whereas a coal in shining wafts it self at a great rate, shining wood does not.

These two differences I mention together; because what concerns the coal in both, will need no proof; and as for what concerns rotten wood, it may be verified by an observation, that I made in a piece of it hermetically sealed up in a small clear glass; where, after it had continued luminous for some days, I looked on it in the day-time, to perceive, if any store of spirits, or other steams, had, during all that while, exhaled from the wood; but could not find any on the inside of the glass, except that in one place there appeared a kind of dew, consisting of such very small drops, that a multitude of them would go to the

NAT. HIST. the making up one ordinary drop. But in pieces of shining fish, I found the case much otherwise, as was to be expected.

6. The last difference I shall take notice of betwixt the bodies hitherto compared, is, that tho' a quick coal be actually and vehemently hot; I have not observed shining wood to be so much as sensibly lukewarm.

What is said of the coal's heat, being as manifest as its light, I shall need only to make out what relates to the shining wood. To assist me wherein, I meet, among my notes, the following experiment.

I put upon a large piece of wood, which was partly shining, and, as near as I could, upon one of the most luminous parts of it, one of those thermometers, that I make with a pendulous drop of water. But as I had formerly tried, that by laying the tip of my nose, or finger, upon it, when it shone vividly enough, to enable me to discern both the one and the other at the time of contact, I could not perceive the least of heat, but rather an actual coldness; so by this trial I could not satisfy my self, that it did visibly raise the pendulous drop, tho' the instrument were so tender, that by approaching one finger near it, yet without actually touching it, 'twould manifestly be impelled up; and upon the removal of my finger, presently descend again.

And I remember, having put such an instrument upon a shining fish, that was pretty large, I could not thereby perceive, it had any degree of heat, but rather the contrary: and having several times taken off the glass, to apply it with the more advantage to several parts of the luminous fish, I often took notice, that upon the removal of the glass into the air, the pendulous drop would manifestly rise a little, and subside again when the glass was applied to the fish. But whether this part of the experiment will hold in all temperatures of the air, I had not opportunity to try.

Observations  
upon shining  
fish.

1. Febr. 15. 167 $\frac{1}{2}$ . When I was about to go to bed, an amanuensis of mine informed me, that one of the servants of the house, going, upon some occasion, into the larder, was frightened by something of luminous that, notwithstanding the darkness of the place, she saw, where meat had been hung up before. Upon this I presently sent for the meat into my chamber, and caused it to be placed in a corner of the room, made considerably dark; and then plainly saw, with wonder and delight, that the joint of meat did, in divers places, shine like rotten wood or putrid fish. The chief circumstances and phenomena, that I had opportunity to take notice of, at so inconvenient an hour, were these.

1. But first I must observe, that the subject, I speak of, was a neck of veal, which had been bought of a country-butcher on the *Tuesday* preceeding.

2. In this one piece of meat I reckon'd distinctly above twenty several places that shone, tho' not all of them alike; some of them doing it but very faintly.

3. The

3. The size of these lucid parts was different; some of them being as big as the nail of a man's middle finger, some few bigger, but most of them less. Nor were their figures at all more uniform; some being inclined to round, others almost oval, but the greatest part of them very irregularly shap'd.

4. The places that shone most, were some gristly or soft parts of the bones, where the butcher's cleaver had passed: but these were not the only luminous parts; for by drawing to and fro the *Medulla spinalis*, we found that a part of that also shone not ill. And I perceived one place in a tendon, to afford some light; and, lastly, three or four spots in the fleshy parts, at a large distance from the bones, were plainly discovered by their own light, tho' that were fainter than in the parts above-mentioned.

5. When all these lucid parts were survey'd together, they made a very splendid shew: so that applying a printed paper to some of the more resplendent spots, I could plainly read several succeeding letters of the title.

6. The colour that accompanied the light was not in all the same: but in those which shone liveliest, it seem'd to have such a fine greenish blue, as I have often observed in the tails of glow-worms.

7. But notwithstanding the vividness of this light, I could not, by the touch, discern the least degree of heat in the parts whence it proceeded; and having put some marks on one or two of the more shining places, that I might know them again when brought to the light, I for a pretty while apply'd to them a sealed weather-glass, furnished with tinged spirit of wine, but could not satisfy my self, that the shining parts did at all sensibly warm the liquor.

8. Notwithstanding the great number of lucid parts in this neck of veal, yet neither I, nor any of those who were about me, could perceive the least ill scent, whence to infer any putrefaction; the meat being judg'd very fresh, well conditioned, and fit for dressing.

9. The floor of the larder, where this meat was kept, is almost a story lower than the level of the street, being divided from the kitchen but by a partition of boards, and furnished but with one window, which is not great, and looks towards the street, that lies northward from it.

10. The wind, as far as we could observe it, was then at south-west, and blustering. The air, by the seal'd thermometer, appeared hot for the season. The moon was past its last quarter. The mercury in the barometer stood at  $29\frac{3}{4}$  inches.

11. We cut off, with a knife, one of the luminous parts, which proved to be a tender bone, about the thickness of a half-crown piece, and this appeared to shine on both sides, tho' not equally; and that part of the bone, whence it had been cut, continued joined



NAT. HIST. to the rest of the neck of veal, and was seen to shine; but nothing near so vividly as the part we had taken off did before.

12. To try, whether I could obtain any juice, or moist substance, from this, as I have several times done from the tails of glow-worms, I rub'd some of the softer and more lucid parts, as dextrously as I could, upon my hand, but did not at all perceive any luminous moisture was thereby imparted; though the flesh seem'd by that operation to have lost some of its light.

13. I caus'd also a piece of shining flesh to be compress'd betwixt two pieces of glass; but I did not find the light to be thereby extinguish'd.

14. I put a luminous piece of the veal into a crystalline vial; and pouring on it a little pure spirit of wine, after I had shaken them together, I laid by the glass, and in about a quarter of an hour, or less, I found that the light was vanish'd.

15. But water would not so easily quench our seeming fires; for having put one of them into a *China* cup, and almost fill'd it with cold water, the light did not only appear, perhaps undiminish'd, through that liquor, but above an hour after was vigorous enough not to be eclips'd, though look'd upon at no great distance from a burning candle.

16. While these things were doing, I caus'd the pneumatical engine to be prepar'd in a room without fire, (that the experiment might be try'd in a greater degree of darkness;) and having convey'd one of the largest luminous pieces into a small receiver, we caus'd the pump to be plied in the dark; and perceiv'd, upon the gradual withdrawing of the air, a gradual lessening of the light; which yet was never brought quite to disappear, (as the light of rotten wood and glow-worms wou'd have done) or to be so near vanishing as one would have expected. But by the hasty increase of light, that disclos'd it self in the veal, upon letting in of the air to the exhaust'd receiver, it appear'd more manifestly than before, that the decrease, though but slowly made, had been considerable. This trial we once more repeated, with like success; which, though it convinc'd us, that the luminous matter of our includ'd body, was more vigorous, or tenacious, than that of most other shining bodies; yet it left us some doubt, that the light would have been much more impair'd, if not quite made to vanish, if the subject of it could have been kept long enough in our exhaust'd receiver.

17. It was also found, that a leg of the same veal, had some shining places in it; though they were but very few and faint in comparis'n of those conspicuous in the above-mention'd neck.

18. *March 16.* Between four and five in the morning, I look'd upon a clean vial, that I had laid upon the bed by me, after a piece of our luminous veal was includ'd in it, and found it to shine vividly. I look'd upon it again the third day, inclusively, after we had  
first

first observed the meat 'twas cut off from to be luminous, and I found it to shine in the dark as vigorously as ever: on the 4<sup>th</sup> day, its light was also conspicuous; so that I was able, in a dark corner of the room, to shew it even in the day time to three or four very ingenious physicians. But before the night following, the light began to decay, and the offensive smell to grow somewhat strong; which seems to argue, that the disposition, upon whose account our veal was luminous, may very well consist, both with its being, and not being in a state of putrefaction, and consequently is not likely to be derived merely from the one or the other. The 5<sup>th</sup> day, in the morning, looking upon it before the curtains were opened, it seemed to shine better than it had done the day preceding. The same night also it was manifest enough, though not vivid, in the dark. When I awaked, the 6<sup>th</sup> day in the morning, after the sun was risen, I could within the curtains perceive a glimmering light; but the 7<sup>th</sup> day, I could not, late at night, discern any light at all.

19. I shall only add one observation more, which may possibly take our thoughts from attempting to deduce the shining of our veal from the peculiar nourishment, constitution, or properties of that individual calf, whose flesh it was. For, having several nights sent purposely into the larder, to observe, whether any veal, since brought thither, or any other meat, did afford any light, a negative answer was always brought me; except at one time, which happened to be within less than 48 hours of that wherein the luminousness of the veal had been first taken notice of; for at this time there was in the same larder, a conspicuous light seen in a pullet, that hung up there; which having caused to be brought up in a darkened part of my chamber in the night time, I perceived four or five luminous places, that were not indeed near so large as those of the veal, but were little less vivid than they. All of these, I took notice, were either upon or near the rump; and that which appeared most like a spark of fire, shone at the very top of that part. Yet was not this fowl putrefied, nor at all ill-scented, but so fresh, that the next day I found it very good meat. And thus much for natural \* Phosphori:

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\* The mercurial phosphorus is a late discovery; and has been laboriously treated of by M. Bernoulli, who seems to claim the honour, if not of the invention, yet of having reduced the phenomena to rules, and settled the doctrine thereof. The late Mr. Hawksbee, also, has made many experiments relating to this matter; whence it appears, that light is producible from quick-silver, by passing common air thro' the body of it, after the glass receiver is well exhausted; that a peculiar figure, and motion of parts, and a pro-

per medium for those motions to be perform'd in, are requisite to the production of this light; that a much less rarified medium than a vacuum, is sufficient for the exhibition of this phenomena; and that light is producible by the agitation of mercury in the open air, tho' this be very different from that produced *in vacuo*, or a highly rarified medium; the luminous parts in the former case being distinct and separate, but united into a continued body in the other. But perhaps,

NAT. HIST. *phosphi*: we shall next proceed to consider the artificial kind:

haps, the phenomenon is, in some degree, owing to the friction of the glass; for this being briskly rubbed with a dry body, will afford a light in a dark place. See *Hauksbee's Physico-Mechan. Experiments*, p. 6—20, and p. 45—52.

It appears also from other experiments of the same curious person, that light accompanied with heat, is producible *in vacuo*, by the friction of amber upon woollen. And M. Bernoulli informs us, that the attrition of a diamond may produce a light as vivid and strong, as that of a glowing coal briskly agitated with bellows.

"Do not, says Sir *Is. Newton*, all fixed bodies, when heated beyond a certain degree, emit light and shine; and is not this emission performed by the vibrating motion of their parts? And do not all bodies which abound in terrestrial parts, and especially in sulphureous ones, emit light as often as those parts are sufficiently agitated; whether that agitation be made by heat, or by friction, or percussion, or putrefaction, or by any violent motion, or any other cause? As for instance, sea-water in a raging storm; quick-silver agitated *in vacuo*; the back of a cat, or the neck of a horse, obliquely struck, or rubbed in a dark place; wood, flesh, and fish, while they putrefie; vapours arising from putrefied waters, usually call'd *Ignes fatui*; stacks of moist hay, or corn growing hot by fermentation; glow-worms, or the eyes of some animals by vital motions; the vulgar phosphorus agitated by the at-

trition of any body; or by the acid particles of the air; amber, and some diamonds, by striking, pressing, or rubbing them; scrapings of steel struck off with a flint; iron hammer'd very nimbly, till it become so hot, as to kindle sulphur thrown upon it; the axle-trees of chariots taking fire by the rapid rotation of the wheels; and some liquors mixed with one another, whose particles come together with an impetus. So also a globe of glass, about 8 or 10 inches in diameter, being put into a frame, where it may be swiftly turn'd round its axis, will, in turning, shine where it rubs against the palm of one's hand apply'd to it: and if, at the same time, a piece of white paper, or white cloth, or the end of one's finger, be held at the distance of about a quarter, or half an inch, from that part of the glass where it is most in motion; the electric vapour, which is excited by the friction of the glass against the hand, will, by dashing against the paper, cloth, or finger, be put into such an agitation, as to emit light, and make the paper, cloth, or finger, appear lucid like a glow-worm; and in rushing out of the glass, will sometimes push against the finger, so as to be felt. And the same things have been found, by rubbing a long and large cylinder of glass, or amber, with a paper held in one's hand, and continuing the friction till the glass grew warm." *Newton. Optic*: p. 314—316.



T H E



# T H E A E R I A L N O C T I L U C A.

## S E C T. I.

**I** Here propose to speak only of the artificial phosphori\*. And, *The sever*  
as far as I have hitherto observ'd, those factitious shining bodies, *kinds of*  
that pass under the name of phosphori, may be reduced to two *ficial phosphori...*  
principal kinds; one of which may be subdivided into two or three.  
The first of these consists of such bodies, as shine, for some time, in the  
dark, only after being expos'd to the rays of the sun, or of a vigorous  
flame; of this kind is the *Bolonian* stone, skilfully prepared, and the  
*Phosphorus hermeticus* of *Balduinus*; which proved therefore very welcome  
to the curious, because the *Bolonian* stone was for some years before  
grown exceeding scarce, even in *Italy*. And this, an ingenious traveller,  
then lately come out of those parts, imputed to the death of the  
person who used to prepare the stone, at *Bologna*; without having left  
a sufficient account of his way of making it lucid. And the phos-  
phorus of *Balduinus*, which, or the like, may be made both of chalk,  
and another substance, seem'd to me, when the preparation succeeded  
best, to catch the external light far more readily than the *Bolonian*  
stone. For I have had of it, that, when fresh made, wou'd, within  
about half a minute, be manifestly excited, and as it were kindled;  
so that being presently removed into a dark place, it wou'd retain  
a very sensible light, tho' the external luminary whereto it had been  
exposed, were but the flame of a candle.

But as these phosphori cou'd very hardly be preserv'd for any long  
time, so some of them in a few months, and others in a few weeks,  
wou'd appear crack'd, and lose their faculty of being excited by the  
beams of light; whilst the *Bolonian* stone, skilfully prepared, wou'd

\* " Phosphori in general; says M. Le-  
" mery, may be looked upon as a kind of  
" sponges, full of luminous matter, which  
" they contain so loosely, that a small

" external force will strike it out, and  
" give it a luminous form." *French Mé-  
moirs*. A. 1709. p. 542.

retain

retain this faculty much longer. For I had a small piece of it, which, tho' kept negligently, in an ordinary wooden box, preserv'd its virtue for several years.

But besides this first kind of phosphorus, which, to be able to shine, must have its faculty excited by the beams of the sun, or of some other actually shining body; there is another sort which needs no such assistance, yet continues to shine far longer than the *Bolonian* stone, or the phosphorus of *Balduinus*. This by some has been called a *noctiluca*, but more properly a self-shining or luminous substance; and of this Mr. *Krafft*, a German chymist, shew'd his majesty two sorts or degrees. To the first whereof, I gave the name of consistent, or gummous *noctiluca*; this substance being at least as yielding as bees-wax in summer, and its texture not very unlike that of cherry-tree gum. And on account of its uninterrupted action, 'tis term'd by some in *Germany*, the constant *noctiluca*, which title it deserves; since this phosphorus is by far the noblest we have yet seen. For tho' there were not much of it, and tho' kept by it self, in a little vial well stopped, it would, without being externally excited, incessantly shine, as he affirmed, both day and night; yet the light it afforded, seem'd but little, if at all more vivid than I have sometimes observed in the liquor of glow-worms, and other natural phosphori.

Besides this gummous *noctiluca*, Mr. *Krafft* had a liquid one, that, perhaps, was made only by dissolving the former in some convenient liquor, tho' the lucidness of this was not permanent like that of the other; but within no very long time, especially when 'twas divided into smaller portions, and left exposed to the air, wou'd expire or vanish.

And besides the gummous, and the liquid *noctiluca*, hitherto mentioned, we may add a third kind that we our selves lately prepared, which seems to be of a somewhat different nature from them both; for ours wou'd not shine of it self, like the constant *noctiluca*, nor yet after the manner of the liquid *noctiluca*; but the bare contact of the air, without any external rays or heat, would therein, immediately produce a light, that might easily be made durable in a well-stopped vessel; and, which is considerable, the shining substance was not the body of the liquor included in the vial, but an exhalation or effluvium, mix'd with the admitted air; for both which reasons I gave it the name of the aerial *noctiluca*.

These are the several phosphori that I have yet seen; but future industry may discover some new kinds or variations of self-shining substances, which will deserve new names; and among them, perhaps, that of solid *noctiluca*'s.

After Mr. *Krafft* had shewn me both his liquid and consistent phosphorus; being, by the phenomena I then observed, made certain, that there is really such a factitious body to be made, as wou'd shine in the dark, without having been before illumined by any lucid substance, and without being hot as to sense; I considered in what way it might be most probable to produce, by art, such a shining substance. Mr. *Krafft*, indeed, gave me in return of a secret I communicated to him, a re-

a remote hint of the principal matter of his phosphori, by saying it was somewhat that belong'd to the body of man. NAT.HIST.

But I made many fruitless attempts, with many unlucky accidents, before I cou'd bring the thing to bear; till, at length, being confident upon the nature of the thing, I would not believe the skilful labourer when he told me, with concern, that what I expected was not produced; but going my self to the laboratory, I quickly found, that by the help of the air, or some agitation of what had pass'd into the receiver, I cou'd, in a dark place, tho' it was then day, perceive some glimmerings of light.

But this tedious pursuit only gave me a liquid phosphorus, not such a solid one as that of Mr. Kraft; and I was willing to think, that this defect might be imputed to the cracking of the retort, before the operation was quite finished. However, I have, by this means, found a substance that needs nothing but the air to kindle it, and that in a moment.\*

The uses that may be made of a noctiluca, especially of the consistent kind, are not, in probability, to be all of them easily fore-  
seen. But if the lucid virtue of the constant noctiluca cou'd be considerably invigorated, it might prevent a great deal of danger to which ships are expos'd, by the necessity men often have to come into the gun-room, with common flames, to take out powder. And, perhaps, our light may be of use to those who dive in deep waters; and might very safely and conveniently be let down into the sea, to what depth one pleases, and kept there for a long time, to draw together the fish, that will resort to the light of a fire or candle; as is practis'd in several parts of Scotland and Ireland, by the fishermen.† The self-shining substance, which is our aerial noctiluca, affords a light, that was able, when I wak'd in the night, to shew me distinctly the bigness and shape of some joints of my fingers, and discover'd it self in the form of a capital letter, cut out of a piece of black paper, pasted upon the vial; so that it may, probably, suffice to shew the hour of the night, when one wakes, if it be placed, instead of a lamp or candle, behind an index, where the figures employed to mark the hours, are cut out. It may also serve to make a guide knowable at a distance, in tempestuous winds, great showers, and the darkest nights. Probably, also, so subtle and noble a substance may have great medicinal virtues. And tho' our noctiluca had none of these, yet

The uses of phosphori.

\* From Mr. Hawksbee's experiments, made with the phosphorus of urine, it appears, that its light is improved, or made more distinct, by the rarification of the air; or the taking off the pressure of the atmosphere. See Hawksbee's *Experim.* p. 122—124.

† For these and the like purposes M. Bernoulli's perpetual, portable phosphorus,

seems much better contriv'd. This phosphorus is only a proper quantity of well purified mercury, inclosed in a very clean glass vessel, thoroughly exhausted of air; for such a vessel being barely shook, will afford a very considerable light in the dark, without the least danger of fire.



NAT. HIST. it may be highly valuable, if it shall be found conducive to discover the nature of light.

But to come to what I here chiefly intend, the observations we made upon our noctiluca.

Observations  
upon the

1. The vessels not holding entire to the last, we had more difficulty than we expected, to get out the shining matter; and were obliged to save as much as we cou'd of it, by small parcels, in distinct vials, whereof, tho' the first was judged to contain the most vigorous portion of the shining liquor, yet I thought fit to make my trials with the noctiluca, saved in the second; setting aside some more faint and aqueous liquor, that we afterwards saved in a third vial; with a thicker matter that remained upon a paper, when some of the liquor had been put into it to be filter'd; and this paper we kept in a fourth glass, which, tho' wide-mouthed, was carefully stopp'd.

2. The second vial was capable of holding about two ounces of water; but it contained not above one spoonful of our shining liquor; which by day-light appeared muddy, and of a greyish colour; somewhat like common water render'd opaque, by a quantity of wood-ashes well mixed with it. When no light appeared in the glass, we observ'd all the cavity that reached from the liquor to the neck, to be transparent; as if there were nothing but a spoonful of dirty water at the bottom of it. But when the liquor was made to shine vividly, all the cavity of the glass unpossess'd by the liquor appeared, in an external light, to be full of fumes; which, being, in the containing vial, removed into a dark place, appeared lucid; and sometimes like a flame that seem'd to be reverberated; and to be made, as it were, to circulate by the close stopp'd neck, and the sides of the vial. And the appearance of whitish fumes, when the glass was look'd upon in an external light, was so usual a concomitant of its fitness to shine in the dark, that upon viewing the vial by day-light, I cou'd readily tell, by the presence or absence of that mist, whether the matter wou'd, in a dark place, appear luminous or not?

3. When this liquor had been kept for an hour or two, in some dark, quiet place, or even in the pocket; if in a darkned room, my eyes were cast toward the place where the vial was held, I cou'd not perceive it to afford any light at all; and tho' the liquor were strongly shook, yet I cou'd not discern, that this motion alone was able to bring it, or its vapours, to be manifestly lucid. But as soon as I unstopp'd the vial in the dark, there began to appear a light, or flame, in the cavity of it. Whatever be the nature and subject of this light, it appeared to have a great dependance on the fresh air: for, (1.) I never observed it, either in the liquor, or upon the surface thereof; but still the shining began at the upper part, which was first touched by the outward air, and made a progress quick indeed, tho' not so instantaneous, but the eye cou'd follow it from the top to the bottom of the vial.

(2.) The

(2.) The contact of the air seemed necessary to the propagation, as *NAT. HIST.* well as the production of this flame or light; for if having shaken the vial, that the liquor might either wet the stopple, or communicate something to it, I warily bent the cork, so that only a few particles of the outward air cou'd insinuate themselves between the stopple and the neck of the glass; there would appear on the sides, and, perhaps, beneath the cork, little flames, as it were; which yet, tho' very vivid, were not able to propagate themselves downwards; but when the cork was quite removed, and access thereby allowed to a greater quantity of air, the flame, or light, presently diffused itself thro' the whole cavity of the vial, and reached as low as the surface of the liquor.

(3.) Tho' often the light seemed more vivid near the surface of the liquor than elsewhere, yet when by stopping the vial again, presently after I had open'd it, I endeavoured to destroy the flame, or light; I generally observed, that when it was ready to vanish, it began to disappear first at the bottom of the vial, and seemed to shrink more and more, as it were upwards, till it expired at the neck. (4.) But, on the other side, when I kept it unstopp'd for two or three minutes, tho' I afterwards stopp'd the vial very close; the air, that had more leisure than ordinary to insinuate itself, wou'd so cherish the flame, that the light wou'd continue sometimes for an hour or two, and once or twice it lasted no less than three hours. Lastly; it seemed that some elastic particles of the included air, or some substance that concurr'd to maintain the flame, was wasted or depraved, and weaken'd by being pent up in the vial with the effluvia of the liquor; since when the vial had been kept stopp'd for a competent time, and its cavity appeared transparent in the outward light, if I cautiously took out the stopple, the external air seemed manifestly to rush in, as if the springyness of the internal had been notably weaken'd by the operation of the flame upon the matter with which it was kept imprisoned. And altho' in the vial, moderately shaken, when the light was quite vanished, I cou'd not make the liquor begin to shine; yet when by unstopping it a little, the flame was kindled in the cavity of the glass; then by shaking it again, tho' more faintly than before, the light seemed to be manifestly increased.

4. If I laid a little of our liquor, when it was in its dark state, upon my hand, or on the stopple of the vial, it wou'd often remain there, without disclosing any glimpse of light; but if I rubb'd it with my finger, it wou'd shine more vividly than it used to do, at best, in the vial, when the neck of it was stopp'd; and this vivid light, whilst I continued to rub the matter, seemed, from time to time, to flame and flash; and not only smelt offensive, but visibly sent up a large smoke, as if it had been some common, culinary flame; and when, upon ceasing to rub the liquor, it had ceased to shine for a pretty while; yet when I rubb'd it again, it wou'd again appear luminous. But by little and little the lucid virtue decay'd, till 'twas in vain to rub any more.

NAT. HIST.

5. The light of our liquor, when excited, seemed, for degree, much like that observed in some species of rotten wood, tho' not the most vivid sort; and when surrounded with bodies of a black colour, the reflection of it from them, was little or none. But very white bodies held contiguous to it, were manifestly illumined by it; especially if the eye, having been long kept in the dark, was made more susceptible of the fainter impressions of light; so that waking before break of day, and inclosing both the glass and my head between the bed-clothes, the light seemed to be very considerable, and illumined the compass of a foot or more in diameter; and, probably, would have diffused itself further, if it had not been bounded by the sheets; whose whiteness made the reflection of the light from them appear very prettily. And, by the help of this light, I could easily perceive my fingers, and a ring I wore; tho' I could not distinguish the colours of a reddish diamond, and two emeralds, that were set in it. With regard to the light within, the included flame of our vial was opaque; for both at some other times, and when I made the last observation, I could not at all perceive my finger, when the shining substance was interposed betwixt it and my eye. But, in reference to the external light, the flame, or shining matter, was transparent; for even in a very faint light, by which, I think, I could scarce have read an ordinary print; if I held our luminous vial between the window and my eye, I could very plainly see my finger on the further side of the glass; tho' if my eye were placed between that and the light, the transparency would appear somewhat lessened; because the cavity seemed fill'd with a kind of whitish mist. The like transparency, and whitish fumes, observable in the same luminous steams or flame, when the vial was look'd on against and from the light, I found, if instead of the day-light, I employed that of a candle.

6. Having the opportunity of a convenient place, and a fair day, I set the vial, about noon, in a window, opened towards the south, and left it there expos'd to the sun-beams for a considerable time; to try, whether they would, upon account of their agitation, or some imaginable affinity of nature, kindle or excite the liquor, or its effluvia. But I could not perceive that the sun-beams had such an operation; nor could I perceive any whitish, or mist-like fumes, in the cavity of the glass; nor any light in the vial, placed in the darkest corner of the room.

7. Acid and alkaline spirits, being reckoned the most subtile and operative substances, obtainable from mixed bodies by distillation; I thought it worth while to try by the taste, whether our shining liquor abounded with particles of either of those kinds? I did not, however, find, that the liquor I put upon my tongue, was, in the least, acid; nor that it was sensibly alkaline, as the salts and spirits afforded by hartshorn, blood, &c. but it seemed to have an odd, empyreumatical taste, almost like the spirit of crude tartar; its smell resembling



that of some empyreumatical oil, with a scent somewhat like NAT. HIST.  
stale urine. I likewise, for further trial, put a little of our liquor  
to some drops of blue syrup of violets; but the mixture was not  
thereby turn'd green, which it wou'd have been by a quarter so much  
spirit of hartshorn, of blood, or of some other spirit abounding with  
salt of an urinous nature.

8. Some other trials I made, with very small quantities of our  
liquor; but these no more than the former shewed it to belong  
manifestly to the tribe of acids; or to that of alkalies\*. Sometimes  
when I shook the vial, so that the whole body, even to the bottom  
of the liquor, was spread all over the inside of the glass; I could  
observe, that in many places, several little grains, or corpuscles, be-  
longing to the opaque matter, that concurr'd to compose the liquor,  
stuck here and there to the inside of the vial; and that these being  
of a consistent, not a fluid nature, and therefore, probably, more dense  
than the thinner parts of the phosphorus, shone very prettily and di-  
stinctly, almost like extremely little stars, or rather, radiant sparks  
of fire, whose light was brisk enough to be distinctly visible, not-  
withstanding that of the flame was contiguous to them, and filled  
the cavity of the vial. And these shining corpuscles usually continued  
peculiarly vivid, as long as I thought fit to look on them.

9. Being desirous to try, what water would do towards quenching our  
shining liquor, I thought fit to make the experiment, when time and  
many trials had much impaired its vigour. And, accordingly, having in  
a dark place unstopp'd the vial, and wetted the tip of my finger with  
the included liquor, I could not perceive that it then gave any sen-  
sible light; wherefore, having briskly rubb'd the moisten'd finger  
against my other hand for a few moments, both the rubb'd part of my  
hand, and my finger, appear'd adorned, each of them, with a flame;  
and tho' upon dipping my finger in water, the flame was, as it were,  
extinguished, since the light presently vanished; yet having taken  
it out again, and rubb'd it, without previously drying it upon  
the other hand, as I had done before, the light quickly appeared  
again.

10. Having one night opened the vial, I quickly stopp'd it again,  
and put it in my pocket till I went to sleep; and then laying it by me  
in the bed; when the candles were carried out of the room, I per-  
ceived the light, whose duration I did not expect would exceed one  
hour, to continue still vivid; then shaking the glass a little before I  
composed my self to sleep, I laid it by till I waked in the morning;  
when looking upon it again, it appeared to shine more vigorously than  
it had done at first: and from the time I open'd it, over-night, till

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the

\* The phosphorus of urine, when ana-  
lyz'd, yields a very acid liquor, and a  
terrestrial, unctuous substance; the for-  
mer whereof is not at all inflammable,  
and the latter will scarce burn. See *Me-  
moir. de l'Acad. R. A.* 1706. p. 350.

*NAT. HIST.* the last time I had occasion to look upon it, the next morning, it had continued shining for 12 hours; to which, whether the extraordinary warmth observed that particular night, had contributed any thing, I dare not determine; but shall rather add, that tho' the phenomenon happen'd very rarely, yet this was not the only time I observed it; for once more it occur'd to me, and then the light continued about fifteen hours, that I took notice of; how much longer it might have lasted, I was hindered from observing. But this circumstance seem'd considerable, that the long duration of our unburning flame happen'd after the rest of the trials and observations had been made; when by them the vigour of the shining matter might reasonably be expected to have been very much impair'd.

11. But after the foregoing observations had been made with our second vial; coming one night to open it, in order to shew the phenomenon to a friend, I found no light at all appear, tho' I shook the contained liquor, and kept the vial for a pretty while unstopp'd; till having taken out some drops of the liquor, and rubb'd them upon my hand, they afforded so vivid a light, or flame, as satisfied him of the possibility of a true noctiluca. And since that time I have not found the vial to afford any light, barely upon its being unstopp'd; so that either some bodies unskilful curiosity has, unknown to me, spoil'd the liquor; or else so little a quantity as I had at first, is by the many and various trials I made with it, dispirited and exhausted.

12. But as the air may concur to the shining of our noctiluca, by exciting a certain kind of brisk motion in the parts of it; I thought fit to try whether, tho' I had found the bare shaking of the vial to be ineffectual, yet an actual heat, whereby the parts must be more vehemently and variously agitated, might not enable the air to do what otherwise it cou'd not perform: I therefore held our vial near the fire till it grew considerably warm; and then by shaking it a little, and unstopping it in a dark place, I perceiv'd the exhalations that possess'd its cavity to shine as formerly, but their light was very momentary; and tho' afterwards it sometimes appeared, it was not vivid, nor lasted for a minute, or perhaps half so long; tho' it seem'd that when fresh air was then allow'd access, its duration was thereby somewhat lengthen'd.

I now proceed to our other vials.

*Phenomena  
of another par-  
cel of the ae-  
rial noctiluca.*

A small portion of liquor, not much exceeding a spoonful, that was the first I saved, being put into a long and somewhat slender cylindrical vial of crystalline glass, afforded us the ensuing phenomena.

Soon after the muddy liquor was poured into the vial, it appeared vigorously luminous, and continued to shine for ten hours, that I took notice of.

And presuming the shining matter was not so much the liquor it self, as an aggregate of such effluvia of it, as affected and excited by the air, wou'd become lucid; I thought fit to take particular notice how the air wou'd work upon the exhalations of this more vigorous liquor.

And

And accordingly having fully opened the vial, tho' I very soon after stopp'd it again, I observ'd a great commotion to be made in the cavity of the glass unpossess'd by the liquor; for the new lucid exhalations seem'd to have a brisk, and almost circular motion along the sides of the glass, and to make, as it were, a little whirlwind, that impetuously carried it round; and this renew'd rotation was not only manifest, but lasted much longer than one wou'd have expected; so great a commotion did the air seem to have produced in the effluvia, and perhaps in the neighbouring parts of the liquor it self. Upon the ceasing of this unusual motion, the light did not cease; tho' I observ'd not how long 'twould have lasted.

14. Having heedfully taken out the stopple of our vial, in our dark place, after it had, for a long time, ceased from shining; I observ'd the external air to rush into the cavity of the glass with noise, and so swiftly, that it did, I confess, surprize me; as if the preceeding flame, tho' not sensibly hot, had, after the manner of culinary flames, considerably weaken'd the spring of the included air; and so, disabled it to resist the whole pressure of this external air; when, by the removal of the stopple, it was expos'd thereto. But sometimes, when no such eruption of the air had, in a long time, preceeded, I have observed rotations of lucid matter in the cavity of the vial; which therefore seem to proceed from some other cause; tho' this, whatever it be, produced but such a rotation as was less general, less brisk, and less lasting.

15. Whilst our liquor was yet fresh and vigorous, I dip'd my finger in it, and therewith moistened several parts of my hands, and those of others; upon which we observ'd, that the places touch'd, especially if they were a little rubb'd, shone very vividly, as if actual flames (but not of a blue colour, like that of common sulphur, or of spirit of wine) were burning on them. And these flames were not at all uniform in their manner of burning; for they often seem'd to tremble much, and sometimes, as 'twere, to blaze out with sudden flashes, that were not lasting. And tho' it might seem strange, that so small a quantity of matter, as adhered to this or that part of the hand, shou'd afford so durable a flame; yet if that part were rubb'd against the same person's other hand, or the skin or linen of a by-stander, the part new touch'd wou'd shine as the other continued to do: and tho' these flames were remarkable for their vividness, yet they long continued to afford the company a very pleasing spectacle. And, notwithstanding the darkness of the room, it was manifest, that they emitted great plenty of a whitish smoak, which, or some other effluvia from the same matter, imbued the neighbouring air with a rank and offensive smell. The colour of these seeming flames was not like the phosphorus of *Baldwinus*, when 'tis very well prepared, and has been expos'd to a vigorous light, red, almost like well kindled charcoal; but yellow, like that of the middle part of the flame of a candle. And notwithstanding the blaze and smoak, that accompanied these flames, we could not perceive in them any sensible



NAT. HIST. sible heat; nor did they at all singe the fine linen of the ladies present, whereon some of them seem'd to burn; so that if we admit a *flamma vitalis* in the heart, this unburning and harmless flame may supply us with a far better illustration thereof, than the scorching flame of spirit of wine, that is still commonly employ'd for an example of it.

16. When with my finger dipp'd in this liquor, I drew short lines upon linen, there was left a shining tract upon that part over which my finger pass'd; yet having found it too thick, or too faintly lucid, to be employed like ink in an ordinary pen, I tried whether I cou'd draw lucid letters with a pencil, which, for that purpose, I dipp'd in our liquor; but was surprized to find, that the characters I drew did not at all shine in the dark. Suspecting, however, that the pencil might have retained, among the hairs it consisted of, the more tenacious and vigorous parts of the matter it had imbibed, and left only the more aqueous and strengthless parts upon the paper; I took the pencil in one hand, and with the other compress'd and wreath'd a little the brushy part of it, to excite the matter, that, probably, was lodged there. By which means, that part of the pencil was brought to look as if it were all of a light-fire, and seem'd to burn like a small wax-taper; but with a more blazing and pleasant flame, which, sometimes, shooting downwards, and playing about the hairs of the pencil, appear'd like the lambent flame describ'd in *Virgil*. But this delightful phenomenon decay'd by degrees, till no more light was seen; after which, nevertheless, the flame would, of it self, break out as if it came from the internal parts of the pencil, shine for a pretty while, and then seem quite to expire; yet still it would, on a sudden, disclose it self again; and when it had continued a while in a tremulous motion, die again to all appearance. And tho' this lambent flame did not, that I perceived, burn or singe the slender hairs, among which it seem'd to blaze; yet it always manifestly emitted as much smoak as a common burning taper of that bigness wou'd have done. This vicissitude of extinction and re-appearance of light lasted till I was weary of observing it; and then having again, with my fingers, compress'd and strongly twisted the hairs of the pencil, I made them, as formerly, afford a considerable light, which I thought was in the action, accompanied with a very sensible, but momentary heat. But notwithstanding this heat, 'twas in vain that I tried, by compressing the pencil first, and then rubbing it upon gun-powder, well dried and heated, to fire the powder. This I fail'd in doing, likewise, when I made the trial with circumstances somewhat more likely to render it successful. And indeed Mr. *Krafft*, when he kindled gun-powder at my lodging, was obliged to use his consistent and constant noxtiluca, and to have the gun-powder prepared, by being made so hot, that 'twas almost ready to take fire of it self. But I must not omit what happened to my assistant, when the distillation of our lucid matter had been fresh made; for he having taken up some  
of

of the thicker substance with a knife, to put it into a vial, and finding, that some of it, afterwards, stuck to the blade, he hastily wiped it off with his apron, but was much surpriz'd to feel a smart heat ensue; and presently looking upon that part of the apron, where it had been produc'd, perceiv'd in it two large holes, which both he and I concluded to be produc'd by burning; whence I judg'd it very probable, that the thicker and unctuous part of our lucid matter had a great disposition to admit a very brisk agitation; since by an almost momentary, and not very vehement motion, it was put into an agitation, that made it capable of burning new callicoe, whereof the apron was made.

17. Having employed some of the water that was taken out of a receiver, after it had there been impregnated with the lucid matter; I thought fit to try, whether this water, wherein, probably, the saline particles of our subject might be more copiously dissolved, or more active, would not discover somewhat of a volatile alkali. I, therefore, dropped a little of it upon some syrup of violets, laid on a piece of paper, and found it change the colour of the syrup from blue to green; which yet it did more faintly than the volatile alkalies, even when they are phlegmatic. This liquor likewise made some conflict with spirit of salt; by which I was induced to think, that a volatile alkali, not an acid salt, or spirit, was the predominant, if not the only salt contained in this liquor:

18. I took a vial, containing some luciferous matter, that was not apt to shine long at a time; and being well stopp'd, I kept it till the flame, or light within it, expired; then having placed the glass in a receiver on our pneumatic engine, we pumped out the air, and afterwards pull'd out the cork in a dark place; whereupon there presently appeared some light in the cavity of the vial; but by reason of disadvantageous circumstances, we could not so well pump out the air, and hinder the ingress of new, as not to leave enough to excite a flame, that, by former experience, we found to need but an inconsiderable quantity of fresh air: we observed, however, that by the commotion of the air, occasioned by the pumping, the flame would be blown up, or made to shine more vividly.

19. We afterwards took a pretty large piece of paper, well drench'd in our luciferous matter, and thrust it into a wide-mouthed glass; which being put, unstopp'd, into a receiver, fasten'd to our pneumatic engine, and with it kept in a dark place, did there shine, by reason of the contact of the air, yet contained in the receiver. Presently after this, the pump was work'd, and we observed, as formerly, that the commotion made of the air about the vial, manifestly increased the light for a while; and that the light seem'd to be lessen'd during the pauses intercepted between these commotions, both by reason of the rest, and of the absence of the air. I likewise took notice, that the flame which seem'd to pass from one part of the wrinkled paper

to

NAT. HIST. to the other, sometimes appeared to have, as it were, a palpitation; and to afford a very unequal light: and tho' when the external air was let in thro' the pump into the exhausted receiver, the flame seemed to be quenched; yet I judge that to be only a temporary effect of the waterish vapours, that the air had carried along with it, in its way thro' the pump. I therefore caused the receiver to be taken off the engine; when we observed, that upon the free contact of the fresh outward air, which was not like the former, deprav'd by moist vapours, the matter adhering to the paper quickly shone again, and that more vividly than it had done in the receiver.

*Observations  
upon a third  
parcel of the  
aerial phospho-  
rus.*

20. Besides the liquors that afforded us the foregoing experiments, we saved a little of a substance that was not liquid, yet almost as soft as mud. This we obtain'd, by pouring some of our liquor, taken out of the vessels, when the distillation was ended, into a glass funnel, lined with cap-paper; to try, whether it would filtre. But finding that which passed thro' too thin and aqueous, the filtre was hastily wrapp'd up, and put into a small glass, but of a moderate wideness at the mouth; that both the filtre might be easily thrust in, and the glass be exactly stopp'd with a strong cork.

21. After other experiments had been made, I carried this glass into a dark place; and tho' I could not perceive the least glimpse of light, yet presuming that it contained some of the true matter of the aerial phosphorus, and consequently exhalations, that having been hindered by the stopple from flying away, might be kindled or excited by the appulse of the air; I opened the glass, and saw an immediate appearance of light, which disclosed it self sometimes upon a less, and sometimes upon a much greater part of the very uneven surface of the included paper; and seemed to pass, for a great while, from one part of the filtre, and one side of the glass to another; with a motion so odd and irregular, that it resembled that of fire kindled by sparks, struck into a large quantity of tinder: and this shining faculty, upon the ingress of the air, lasted for many days in the paper.

22. But there was another filtre that afforded us a pleasing variation of this phenomenon; a larger quantity of matter being wrapped up in the inside of the paper, or else being better conditioned than that which adhered to the former. Having unfolded this paper, and kept it displayed in a dark place, we had the pleasure to see a considerable number of flames, of different sizes and figures, disclose themselves at the same time; and tho' most of them were vivid, yet few continued long in the same place; but they seemed frequently to change their situations among themselves, as well as their figures and extent; or else new flames incessantly broke out in new places, according as the exhalations, that, in plenty, mixed irregularly with the contiguous air in several places, happened to be, in part, kindled by it; whilst from the flames themselves, as well as the unshining parts



parts of the filtre, there manifestly ascended plenty of smoke, visible by the light which the shining matter afforded; and these flames did not keep a constant tenor in their blaze, but had their tremblings and emications usually accompanied with changes of figure, and eruptions of light in several places at the same time; whence 'twas very pleasant to see the whole area of the displayed filtre look as the sky sometimes does, especially in hot countries; when the eye perceives flashes of lightning break out in several places at once: but our coruscations being more numerous, made the filtre appear almost as variegated as marbled-paper; but with this advantage, that the appearance was almost perpetually changing; the yellow parts being not only coloured, but lucid; and affording those that looked on them a delightful spectacle, as long as we thought fit to gaze on it.

23. Having strongly suspected, that a due agitation of a disposed matter, was one of the chief agents in the production of light; I was lead to try, whether a more intense heat, which wou'd communicate a brisk and various motion to a multitude of the corpuscles of the luciferous matter, dispersed thro' the liquor, wou'd not do what a fainter agitation was unable to perform. I thought also, it deserv'd to be try'd, whether a considerable variation of phenomena would not follow, upon changing the figure and capacity of the glafs, if all immediate commerce between the cavity of the vessel, and the outward air, were carefully prevented.

In order to both these trials, I took some spoons-full of aqueous liquor, impregnated with some of the more soluble portion of the luciferous matter; which liquor, when settled, was transparent, as containing but an inconsiderable quantity of that muddy substance. And this clear liquor, which being, as it ought to be for my purpose, so faintly impregnated, that it would not with shaking, or a mild heat, afford any light, was put into a round bolt-glafs, whose spherical part was capable of holding three or four times as much; and whose stem was proportionable in wideness to it, and above a foot in length. Having carefully stopped this vessel with a cork, and sealing wax, 'twas in the night-time set so, that, by the means of sand, it might be heated without breaking; and when the ball was made too hot to be well endured in my naked hand, I presently removed the vessel into a dark place; and having shaken the liquor, perceived a light to break out in the ball, which presently diffus'd it self thro' the whole cavity, and as suddenly disappeared. Some time after, especially upon shaking the glafs, the light would break out again, and soon after vanish; and these flashings of light continued for a while to appear now and then; but were unequal as to their extent, vividness, and duration: and when the liquor grew cold, they entirely ceased.

NAT. HIST.

24. But whilst it was yet considerably hot, I thought fit to try, whether, upon breaking the liquor by a strong concussion, some lucid substance would not be made to pass out of the spherical, into the cylindrical part; and so vary the phenomena. And to this purpose, having violently shaken the liquor at several times, with pauses, I perceived some considerable portions of the lucid matter to ascend into the pipe; and particularly once I had the pleasure to see a portion of shining substance, about the bigness of a small almond, mount directly upwards like a flame, but not very swiftly, from the round part of the glass all along the pipe, till it reached the upper part of it. And at other times such flames ascended into the pipe, but not so high; whence many wou'd have confidently inferr'd a positive levity in flame; which yet I forbear to conclude, because I once, at least, observed, one of these portions of shining matter, to descend from the higher to the lower part of the stem; retaining its lucidness all the time.

Perhaps, by the way, the phenomena appearing in this glass, may illustrate, or facilitate, the explanation of what happens in the production and motions of some of those meteors, that are called fiery; such as the *ignis lambens*, falling stars, frequent lightnings without thunder, and that wandering flame called *ignis fatuus*; such bodies being generated when there happens to be a convention of particles so associated, that they mutually agitate each other, or are fitted to be agitated, by a pervading ethereal substance, and put into a motion, like that which in the portions of our shining matter, was able to produce light.

25. Having, by a concussion fit for the purpose, spread, as it were, at once, the liquor all over the inside of the globe, and part of the stem; 'twas pleasant to behold, how the lucid matter, dividing it self variously in its passage downwards, adorned the whole cavity of the glass, with a company of small, lucid bodies, that both shone, and twinkled, like so many little stars: and the pleasantness of the spectacle was increased, by their having manifest motions, as well as true light. The slowness of their descent in lines, many of them very oblique, made this pleasant sight last the longer. And this experiment we repeated more than once.

26. Having at another time, in a like bolt-glass, carefully given a strong shake to the included liquor, when 'twas in a due, but an intense degree of heat; I observed, that on one side of the round part of the glass, and above the body of the liquor, there was generated, as it were, a great spark of lucid matter, about the bigness of a pin's head; whence there was quickly a flame, or light, diffused thro' the capacity of the globe, where it soon after vanished. From which phenomenon, and some others of affinity to it, perhaps it may be argued, that this was a true flame, that from a very small beginning was increased by propagation, and kindled the disposed exhalation, it found dispers'd throughout the cavity of the glass; or that

that the motion of all light is not necessarily instantaneous; since the progress of it was discernible, even in so small a space as our glass compriz'd. NAT. HIST.

27. To try how long I cou'd preserve our liquor in a capacity to exhibit such phenomena, without giving it new air, from time to time, but only by keeping in the spirituous parts; I caused the stem to be hermetically seal'd; presuming, that notwithstanding this, I cou'd, by a certain cautious way of holding the vessel, safely bring the included liquor to an heat sufficiently intense to afford us the phenomena of light; and, in effect, the last recited phenomenon, and some others, were made in the hermetically sealed vessel; and the contained liquor has long continued fit for that purpose.

## SECT. II.

THE shining matter, contained in our best vials, being, at length, partly wasted in experiments, and partly given away; I thought fit to try, whether, by the help of heat, and other motion, our want might not be supplied, till more could be prepared.

1. In pursuit of this design, I took an old vial, that had long lain by as useless, because the noctilucal matter had been poured out of it into a smaller glass; and having held that side of this vial, to which I perceived some feculent matter stuck, near the fire, till it had conceived a considerable degree of warmth, I removed it into a dark place; and found it to shine vividly, whilst it retained a competent degree of heat; and when it cooled too much, the light ceased with the agitation, that, as a cause or a condition, accompanied it. But if afterwards, the vial were again held to the fire as before, the shining power would be excited, and the splendor continue a pretty while. But after some days or weeks, this disposition to be made luminous by external heat, was utterly lost.

2. Having also taken notice of a little feculency, that stuck to the inside of a glass, which had contained some of our noctilucal matter; I imagined, that though it would not shine in the dark by the contact of the air, to which it had been too long accustomed; yet when once that dispirited superficies, that had lain exposed to the air, was removed; the more internal part of the matter might not be destitute of a shining power. I, therefore, carefully scraped off the outer surface, and rubbing a little of the rest with my finger upon my hand, I found it to shine. And though the matter, being once more left exposed to the air, lost, in its superficial parts, the faculty of shining in the dark; yet those parts being taken off, and the remaining matter rubb'd, it appear'd not destitute of a luminous

*Small quantities of the noctiluca, excited to perform the office of larger.*



NAT. HIST.

quality; so that it seemed, tho' the air did, after a while, mortifie, as it were, and spoil the superficial parts that were exposed to its immediate contact; yet this vitiated surface served for a kind of cover, or fence, to the matter that lay beneath it, and kept it from evaporating, or spending those spirituous or subtile parts, on account whereof it was capable of becoming luminous.

3. And as I had observed on other occasions, that liquors abounding in tenacious parts, tho' the liquors did not appear opake or feculent, would leave sticking to the insides of the containing glasses somewhat, that, tho' generally not perceived by the eye, was by some other ways discoverable; I suspected even in a vial that had formerly contained some of our shining substance, tho' it seemed to have been well emptied, and to have no gross feculency adhering to it, there might adhere somewhat which might be made visible by heat or motion; I, therefore, took this glass, and having crackt it into fragments, that it might be put into the neck of a vial of a convenient shape and size, well stoppt the vessel, and removed it into a dark place; we there shook it, and had the pleasure to see, not only that light was readily produced by the motion excited in the jostling of the parts one against another, but that by reason of the various position of the fragments of glass, the light seemed to be vibrated every way, with a very delightful vigour. This production of a kind of blazing light was often repeated with these broken pieces of glass; and if the vial were heated, the effect seemed more sudden and considerable: and even by only warming the vial, without shaking it, a light would be produced.

4. Afterwards, having beaten some of the glass into such small pieces as were capable of passing through the neck of a glass-egg with a flat bottom, that it might stand upright; we hermetically sealed up the neck, to try whether, by hindering the included matter from exhaling or transpiring, we could keep the beaten glass always fit to exhibit the phenomenon: but we found not the event answer; for after no long time, we could no more produce any light in our sealed vessel; tho' an unlucky accident in one of our last trials, keeps me from being fully satisfied that the thing designed is impracticable.

5. Some liquid matter was hermetically sealed up in a bolt-glass, to try whether, by this means, we could, for any long time, preserve the shining faculty of that liquor, wherein it was already exceeding faint, and not to be excited but by a considerable degree of heat, and a vehement agitation of the vessel. This sealed glass having been left in the corner of a window, for a competent time, we at length approached the vessel, by degrees, to the fire; shaking it from time to time, till the included liquor had acquired a considerable degree of heat; then removing it to a dark place, and shaking the vessel somewhat strongly, we perceived that the disposition the liquor had to shine, was very much impaired, but not quite abolished. For there would;  
from

from time to time, upon the rude agitation it was put into, appear little portions of matter that looked prettily, and shone very vividly, like sparks of fire: and some of these appeared in the spherical part of the glass, and some in the neck. Some of them also, seemed as it were fixed to their first station, and others moved up and down, and most of them continued to shine for a pretty while before they disappeared: and when they vanished, few of them did so by degrees; but each luminous speck, when it had lasted out its time, lost its whole light at once.

6. Some new liquid phosphorus being poured into a large vial, that would contain ten or twelve times the quantity; so that the shining matter, having much air included with it, might thereby be assisted to diversify, at least, some of the phenomena afforded by former noctiluca's: I accordingly observ'd in the first place, that the shining steams filled the whole cavity of the large glass, that was unpossessed by the liquor and residue; and that this lighter flame continued much longer at once, than any we have hitherto mentioned; for it remained vivid for several days and nights together, without ever unstopping the vial to give it fresh air. And I observed it to do so for about a week, before my occasions hindered me from regarding it any longer.

*Observations upon a new liquid phosphorus.*

7. I sometimes took notice, that some exhalations or vapours, that appeared considerably luminous, seemed to roll to and fro, like little clouds or aggregates of smoke in the cavity of the vessel; tho' it seemed difficult to determine what should give and maintain such a motion in them.

8. The largeness of the glass being considerable, it happened that, sometimes, when I went into the darkened place where I kept it; so much luminous matter would yield a surprizing sight; but tho' its extent were far greater, yet its intenseness did not much exceed that of the light afforded by noctiluca's of the first sort, as we may call those formerly mentioned. Only this I often took notice of, that, in case I shook the matter gently, the light would appear much more vivid, and, as it were, flash, on and about the surface of the liquor where it was contiguous to the air, more than it did elsewhere. And this splendor was such, that if it had been lasting, I thought it would have made our phosphorus useful for considerable purposes.

9. When after having, for many days, kept this glass stopp'd, so that, at last, it would no longer shine of itself; we supposed it to be reduced to the condition of a phosphorus of the first sort, and accordingly found, that, upon the removal of the stopple, and ingress of fresh air, the cavity would, in a moment, be filled with fumes that look'd white in an enlightned place, but luminous in a dark one; and (probably by reason of the quantity of the air contain'd in so capacious a glass) the light usually continued much longer than in noctiluca's of the first sort.

NAT. HIST.

10. Being desirous to try, whether this more vigorous matter, if it were kept so exactly stopped, that none of the luminous vapours could exhale, would not last very long; I put near two spoonfuls of the liquor, with some of the sediment, into a bolt-glass (with a flat bottom) capable of containing near twice the quantity: this glass being hermetically sealed, the included liquor continu'd to shine without any external help, either of air or heat, for about six days and nights; but then it ceased, nor would be made luminous again by moderate shaking.

11. After having poured out some more of the liquor and sediment that had been kept in our great vial, into a smaller; the remaining matter, having now a greater proportion of air included with it, was very apt to be put into a luminous agitation; and would emit exhalations, that not only fill'd the cavity of the glass, but manifestly moved to and fro in it, after an odd manner. And being one night willing to give a lady, and some other company, the diversion of a new phenomenon; after having opened the vial, and then stop't it again, I shook it, and turned it so, that, much the greatest part of the liquor having been before poured out, the residue was spread over the inside of the glass, to which its particles stuck, because there wanted liquor enough to wash them down: by this means, those little portions of the sediment being not covered, as usual, with water, but exposed to the immediate contact of the air, shone much more vividly than the luminous exhalations; and the light being tremulous and twinkling, as well as brisk, they seem'd to resemble so many little stars in a clear dark night, and continued this sparkling longer than one would have expected, to the delight of the spectators; for whose sake the experiment was several times repeated, and with success.

*The properties of a new  
icy noctiluca,  
or solid self-  
shining substance.*

12. Having, at another time, but by a like method, obtained a self-shining substance of a consistent form; I proceed to give some account of what I observed about it.

(1.) And first, tho' this usually came over in distillation, in the form of many little grains, or fragments, differing, for the most part, from one another, both in bigness (some being of the size of grains of corn, and others of pease, or large cherry-stones) and shapes, which most commonly were irregular; yet when the distillation was carried on prosperously, we obtain'd the desired matter in greater lumps; sometimes as large as small beans, and at others, three or four times as large, but not proportionably thick.

(2.) These lumps, whether small or great, were colourless; and usually when held against the light, transparent; so that many bodies placed beyond them at a convenient distance, might be plainly seen through them. And some of the larger appeared so like such fragments of ice, as being thin, are often very clear, and almost quite destitute of manifest bubbles; that because of this great resemblance, and for distinction  
sake,



fake, I thought it not amiss to call our consistent self-shining substance, the icy, or glacial noctiluca, or phosphorus.

(3.) But when I say, that our noctiluca is transparent and colourless, I mean it only with regard to what usually appeared. For whether it were any real difference in the texture, or constitution, of the body it self, or the effect of some casual junctures of circumstances; but sometimes, especially by candle-light, some lesser fragments appeared not diaphanous, nor always either colourless, or of the same colour; but sometimes reddish, sometimes of a faint, but pleasing blue; and sometimes too, of a colour to which I cannot easily assign a name.

(4.) Our icy noctiluca, or phosphorus, is manifestly heavier *in specie* than common water; in which being put, it readily sinks to the bottom, and quietly lies there.

(5.) This ice-like body, though consistent, is not hard; being far less so than common ice; yet 'tis not so soft, but that 'tis brittle; and will more easily be broken in pieces by the pressure of one's fingers, than receive a shape from thence; however, it may, with care, be spread upon a solid body, almost like unmelted tallow.

(6.) The consistent phosphorus is fusible enough. For though in the air it will not be brought to melt, without some difficulty and waste; yet by the help of hot liquors, and even of water it self, it may, with a little dexterity, be dissolved; which is an observation of good use; because, by means of fusion, several fragments, if the matter be pure enough, may be brought to run into one lump; and in that condition may both be the better preserved, and become fit to be applied to some considerable uses, which cannot so well be made of less, though numerous fragments.

(7.) This glacial noctiluca is, as to sense, cold; but of a texture that disposes it to be easily agitated; and by agitation it becomes hot. And when this solid noctiluca is held in the free air, though perhaps its superficies be wet, it affords a very vivid light, usually surpassing that of the aerial noctiluca; and this light seems to proceed from, if not also to reside in, the body it self.

(8.) When our icy phosphorus is taken out of its receptacle, and exposed to the immediate contact of the free air, it usually emits a wonderful deal of smoke, discernable by the light of the body it ascends from; and this plentiful emission usually lasts as long as the phosphorus is kept in the air.

(9.) But 'tis pleasant to observe, and deserves to be considered, that as soon as plung'd in water, so as to be quite covered with that liquor, it ceases not only to smoke as before, but to shine; as if a thorowly kindled coal were suddenly quenched in water. And were it not for this, our noctiluca would be quickly wasted; but the water, fencing it from the contact of the air, keeps it from spending it self as formerly; and yet does really make but a seeming and temporary extinction of this strange fire. For as soon as 'tis again taken

NAT. HIST. taken out of the water, (though it have lain very long there) it falls to shine again, even whilst 'tis yet dropping wet.

*Observations  
upon the water  
wherein the  
solid noctiluca  
was kept.*

And I have sometimes observed, that when I had so large a piece of noctiluca, that I could conveniently hold one half of it under the surface of the water, and the other half above it, whilst the immers'd part afforded no light, the extant part shone vividly.

13. Conjecturing that the water wherein this noctiluca had been long kept covered, to defend it from the air, though it did not manifestly dissolve the mass, might yet be impregnated, at least, with the more saline, and soluble parts of it; I thought fit to make a few trials upon this liquor.

And first, I found that it had a strong and piercing taste, like that of sea-salt; but more pungent, as if brine were mixed with spirit of salt: and it relished also somewhat of vitriol.

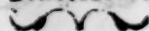
14. Being put into a small, concave vessel of refin'd silver, upon lighted coals and ashes; it evaporated but very slowly, and would not be brought to shoot into crystals, nor to afford a dry salt; but coagulated into a substance, sometimes like a gelly, and sometimes, as to consistence, like the whites of eggs: which substance was easily melted by heat.

15. When this substance was kept a while on a hotter fire, it only boiled at first, but soon after began to make a crackling noise; whilst the explosions were accompanied with flashes of fire and light; which, if small, were generally very blue, like the flames of sulphur, but more vivid, and sometimes also more blue; but the greater cracks, whose noise was considerable, gave a yellow colour, and a very strong light. And these phenomena did not only happen whilst the matter was boiling over the fire, but a pretty while after the vessel was taken off, and held in the air.

16. If, before the coagulated matter was too far wasted by the heat, it were suffered to cool a little, it appeared to have acquired a consistence like melted rosm, or rather, stiff bird-lime; for it would draw out into threads of, perhaps, a foot, or more, in length; and having held one of these threads to the flame of a candle, it did not take fire, but melted into little globules, like capillary threads of glass. And having made some of them stick to the wick of a candle, towards the bottom of the flame; they coloured the lower part of the flame, quite round, with a very fine blue, which lasted much longer than one would have expected.

17. This glutinous substance had, by the action of the fire, acquir'd an odd kind of strong smell, almost like that of garlic; and being left all night in the air, attracted the moisture of it exceeding fast; appearing dissolved, in a great measure, into a liquor almost as strong as spirit of salt.

18. Putting this substance again over the fire, as before, it appeared to be very fix'd; for though there were not so much as a spoon full



full of it, yet it continued boiling for a great while, and afforded a multitude of shining explosions, some whereof made a considerable noise, and gave notable flashes of light, which seemed to proceed from condens'd and agitated fumes, suppressed by the hardened surface of the matter, and kindled in their eruption into the air; whither some parts of these fumes, that were not kindled, escaped, in the form of smoke, whose smell was very strong and rank, but of a peculiar kind. And what seemed strange, though often two, and sometimes more flashes appeared at once, yet so small a quantity of matter continued to afford them for almost an hour together; and, probably, would have done so longer, if I could have watched it.

19. Among other ways of discovering the nature of our icy phosphorus, I thought fit to try, whether it would dissolve in some liquors of different kinds, from whence we might guess at its texture.

*In what liquors the icy noctiluca is, or is not dissolvable.*

We found then, that common water would not, in the cold, dissolve it, though the liquor was thereby impregnated; as when *Crocus metallorum*, or glass of antimony, being infused in wine or water, the menstruum is impregnated with emetic particles; tho' the bulk, shape, and colour of the *crocus*, or the glass, are not thereby visibly diminished or altered.

20. We afterwards put a grain or two of our lucid matter, into a little spirit of sal-armoniac; but this seemed not to make any conflict with it, nor manifestly to work upon it; though, to give the liquor time to make a solution, we left them together for several days. But as soon as we had poured off the spirit, it appeared that it had not by any contrariety, destroyed the power of the noctiluca, which began readily to shine as formerly; and yet might be immediately suppressed again, by suffering the liquor to cover it as before; but when we had, by keeping the vial, for some time, in a moderate heat, impregnated the liquor with it; this liquor, being then dropt into water, had a like effect with that hereafter to be mentioned in the experiment with impregnated spirit of wine.

21. Seeing a volatile and urinous salt would not work sensibly upon our phosphorus, we thought fit to try, what corrosive liquors would do; and accordingly, put a grain or two of our splendid matter into a very small vial, wherein was a little oil of vitriol; that menstruum appearing, in many cases, more corrosive than other vulgar acids; but neither did this menstruum dissolve our icy noctiluca, in the cold; and therefore putting it in some heat, we found, that though it did not manifestly dissolve the shining matter, yet the warmed oil made it melt, and appear, at least for the time, a fluid body; in which it seemed remarkable, that this so fugitive a substance, should be ponderous enough to lie at the bottom of oil of vitriol; one of the heaviest fluids we know, except quick-silver.

22. Afterwards we put a small fragment of our icy phosphorus, into *Aqua fortis*; and though we kept it in that menstruum for two



**NAT. HIST.** or three days, and set the containing vial, for many hours, in a warm place; yet we found the matter so little altered, as to its visible appearance, that we doubted, whether the liquor had dissolved any sensible quantity of it.

23. I put a little of our noctiluca into some oil of turpentine; which not dissolving it in the cold, the small vial that contained it, was left all night upon warm ashes. But though the next day none of the phosphorus appeared any longer in the glass, yet we could not perceive, by two or three different trials, that the oil was much altered by it; and particularly I observed, that though the glass was unstopt, and kept so for a while, yet the ingress of the air did not produce any sensible light: nor did we perceive the upper part of the glass to be full of white fumes, as is usual in several other liquors impregnated with our noctiluca, when they are unstopt.

24. It has rendered the experiments made with the aerial noctiluca, much less acceptable, than otherwise they would have been, to the delicate sort of spectators, that the light produced was accompanied with a very unpleasant smell, that issued out of the vial whenever it was unstopped, to let in the air. But by the help of our icy noctiluca, I found a way to prevent this ungrateful concomitant of our artificial light. For having, in a very small vial, put about a grain of noctilucal matter, and covered it with as much pure essential oil of cinnamon, as wou'd swim less than a finger's breadth above it; we carefully stopt our little vial, and having warily held the bottom of it against a fire, till the phosphorus began to melt, I suffered it to cool; and then unstopping it in a dark place, had the pleasure to see a vanishing indeed, but a vivid light. So that, by this means, I could afterwards shew the production of light to the nicest persons; adding to the pleasure of a delightful phenomena, that of a fragrant smell. But because oil of cloves is more easie to be had good, than the oil of cinnamon, and is also much cheaper, I tried the experiment more fully with that.

25. We put some of our luminous ice, into a little pure oil of cloves; but found, after a considerable time, that, at least, a great part of the matter was undissolved; yet the liquor was richly impregnated with it; as we found by a pretty phenomenon that it afforded us. For the little vial it was kept in, being opened in a dark place, there immediately ensued a kind of flash of light, far more vivid, its small bulk considered, than any liquor had yielded us before. But the brightness of this appearance was, it seems, too great to be lasting; for the flame-like substance usually expired in less than a minute; and sometimes, perhaps, in half that time. And there were two other circumstances particular enough in this phenomenon; one, that sometimes, especially if a candle were in the room, the shining fluid would appear of a pleasant, and somewhat surprizing bluish colour: the other, that the light would cease, whilst there

yet

yet remained in the upper part of the glass, many whitish fumes, such as we have formerly often observed in the aerial noctiluca, to be the usual causes or concomitants of light; as if in our present case the shining substance prey'd on, or resided in only the finer and more delicate particles of the whitish exhalations.

26. Instead of the oil of cloves, we substituted some chymical oil of mace, into which we put a competent quantity of the glacial phosphorus; but though we warmed the bottom of the vial as much as we judged necessary, yet, upon unstopping of it, there appeared no sign of light, though the trial was made more than once or twice, and sometimes with favourable circumstances: which event was the less expected, because the oil made use of, was presented me as very pure, by the same traveller who gave me that of cloves before mentioned; and because also the warmed phosphorus was so well conditioned, that as soon as ever the oil was removed, it shone with an extraordinary vigour.

27. We made also a trial or two with distilled and fragrant oil of aniseeds, to see, if, that being an essential oil, and looked upon as a kind of aromatic one, it would better dissolve the noctiluca, or be impregnated by its luciferous parts; but we found, that it neither dissolved the matter, nor, upon unstopping the containing vial, afforded any light, or so much as whitish fumes; which seemed somewhat strange, because the oil was very subtil, and by its aptness to coagulate of it self, shewed that it was genuine; and not, as common chymical oils too frequently are, sophisticated.

28. Having no more oils fit for my turn, I next tried, whether I could dissolve our shining matter in ardent spirits, which are thought to be near allied to distill'd oils; and having, accordingly, put some of our icy phosphorus into spirit of wine, though the menstruum in quantity, some hundreds of times exceeded the body 'twas to work upon, yet after several days, wherein it stood in a window, exposed to the sun-beams, in the hottest part of the summer; it appeared undissolved at the bottom of the liquor, and scarce sensibly diminished.

29. We weighed in a tender balance, one grain of our glacial phosphorus, wiped dry, and broken into four or five pieces, for the easier dissolution thereof. And to these, in a crystalline vial, we put a convenient quantity of highly rectified vinous spirit; and stopping the vial close, we suffered it to remain for many hours, sometimes in the cold, and sometimes in the sun; but perceived not that near a total dissolution was made of the noctilucal matter; even one of the lesser fragments appearing, as well as the others, undissolved in the bottom of it. However, since a body consisting of such subtil parts, may communicate many of them to a contiguous liquor, without any diminution of its bulk, observable by the eye; I thought fit to try what effects this body had upon the vinous spirit.

*Light suddenly produced in common water, by the help of a liquor not luminous.*

NAT. HIST.

30. And first, I observed, that it did not manifestly discolour the liquor, but left it transparent and limpid, as before; only there appeared some very small earthy corpuscles, like dust at the bottom of the liquor, when being a little shaken, it was attentively view'd.

31. We did not observe that, upon unstopping the vial, and the restored commerce between the inward and outward air, there appeared any flame or luminous exhalations, as is usual upon opening vials that contain the liquid aerial noctiluca.

32. But having, in a dark night, dropt a little of this impregnated spirit into a small *China* cup, with common water in it; tho' the spirit neither in the vial, nor in its passage through the air, disclosed any degree of light, yet as soon as ever the drops came to touch the liquor, they would be as it were kindled by the cold water, and afford little flashes of light, more vivid than the noctiluca it self; giving a splendor that render'd not only the brims of the cup, but many of the neighbouring objects manifestly visible. These coruscations had the property of other lightning, to vanish almost as soon as they appeared; nor would the water, that produced them, by being agitated, shine; but others might immediately be produced, by letting fresh drops fall into the same water; upon whose surface they seemed to diffuse themselves; and they would sometimes leave thereon, for a little while, a faintly luminous film or membrane.

I also thought fit to try, whether our phenomenon would not be produced with hot water as well as with cold; and accordingly found that the impregnated spirit of wine produced rather a greater than a less light in hot water than it had done in cold.

33. At another time, having, in a very good balance, weighed out one grain of our noctiluca, (first wiped dry) we put to it, at several times, that it might the better dissolve, above two thousand grains of spirit of wine, that would burn all away; and yet, which may seem strange, this small quantity of noctilucal matter did so impregnate all the liquor put upon it, that tho' nothing of luminous appeared in the menstruum, nor in any exhalations rising from it, if the vial were unstopped, or the liquor poured out of it into the air; yet as soon as ever 'twas dropt into common water, there would be produced a vivid appearance of light, such as we lately mentioned.

It seemed not very improbable, that these sudden and vanishing flashes might, in great part, proceed from the quick disengagement and extrusion of the noctilucal particles, made by the water; which, diluting the vinous spirit, disabled them from retaining the luciferous corpuscles: as if into one ounce of high rectified spirit of wine, you put half a dram, or a dram of camphire, the liquor will dissolve it, without being thereby manifestly altered as to colour or transparency; but if you drop this solution into common water, the vinous spirit will immediately diffuse it self into the liquor, and let go the corpuscles of the camphire, which float like a white powder upon the sur-



surface of the water. And, accordingly, our impregnated spirit of wine being dropt into some other well deflegmed spirit of wine, we saw no light produced; but when it was dropt into spirit of sal-armoniac, which seems to consist of the volatile salt dissolved in the phlegm or aqueous liquor, the noctilucal corpuscles were by this waterish part freed from the vinous spirit, almost as much as they would have been by common water, and did, accordingly, shine with much briskness.

34. And after having brought one grain of our shining matter to impregnate between four and five ounces of highly rectified spirit of wine, which did, at least, two thousand times exceed the weight of the noctilucal substance; I presum'd that this very parcel of spirit of wine, wherein it was already diffused and scattered into so many thousand corpuscles, as sufficed to impregnate all the liquor, would yet communicate to a large quantity of water particles enow to make it shine, when agitated. Wherefore, when we had weighed out, in a very exact balance, one dram of our impregnated spirit, we mixed it with, and shook it in as much fair water as we thought fit, (but not all at once) till we had to our dram of spirit of wine, put above fifty time its weight of water; and this spirit it self weighing, at least, two thousand times as much as the noctilucal matter, wherewith 'twas impregnated, it follows, that the single grain of icy noctiluca was able to diffuse it self through, and impregnate full a hundred thousand grains of liquor, so as (when duly ordered) to make it luminous. For having presently after the last water was put into the glass, stoppt the vessel close with a cork, and shaken it a little in a dark place, the whole vial appeared to be full of light; which tho' it were not more than ordinarily intense, yet by reason of the bulk of the liquor, made a glorious shew, and discovered many of the neighbouring objects. And after we had done shaking the vial, not only the upper part, which was fill'd with exhalations and vapours, shone like those other liquid phosphori formerly mentioned; but, what was not observed in them, the water it self had a luminousness, tho' of an inferior degree, of its whole mass; for when the glass was shaken, all the liquor appeared to shine, so that we could plainly see through the sides of the vessel, the conical figure of its botttom.

*A strange  
subtily of  
parts in the  
glacial nocti-  
luca.*

After this, I prosecuted the experiment further, increasing the proportion of the water to fresh impregnated spirit; and found, that one part of the noctiluca, being first dissolved in spirit of wine, and afterwards briskly shaken into a convenient quantity of water, rendred as much liquor luminous, as, upon calculation, amounted to four hundred thousand times its weight. And this did not seem to proceed from the irradiation of the luminous corpuscles or exhalations, shining in the empty space at the top of the glass; because the vial was to near fill'd with liquor, that there was but little room left for vapours; and because, also, the vapours that play'd in that space, shone but very faintly; and when the glass was at rest much less than a minute, the  
light

*NAT. HIST.* light would reach but a little way downwards in the water, and yet was there so dim, as to be scarce discernable. But in our experiment, not only the agitated liquor appeared luminous throughout, but the light was brisk.

But lest some should think, that if this experiment had been still further prosecuted, the luminousness would have still extended to greater quantities of water; I shall add, that when I increased the proportion of this liquor to the noctilucal matter, to be dispersed through it, by putting in near three or four ounces of water, more than I guessed would be convenient; the luminous matter seemed to be, as it were, drowned or lost in so much liquor; for tho' we gave it much more agitation than had, in the former experiments, produced light; yet no luminousness at all appeared in the fresh spirit: and shaking it into such a quantity of water, as I thought it might serve to impregnate, I found that the luminous mass of liquor, thereby produced, amounted to more than five hundred thousand times the weight of the noctilucal matter dispersed through it; which is a visible expansion very much greater than, I think, has been hitherto observed in any corporeal substance dissolved in a visible liquor; since it four times exceeds that I made with cochineal, and which has been taken notice of as a prodigious thing; one part of the cochineal, having in that experiment produced a discernable colour in an hundred twenty five thousand parts of water.

But I here only deliver the manifest impregnation of the water it self, which is a gross and tangible liquor, by the dispersed particles of the noctilucal matter; and have made no estimate of the incomparably greater expansion of the light, that from the matter included in the vial, illuminated the ambient air, to a considerable distance from it; tho' by reason the darkened room was not large, I was disabled to make an estimate how far the enlightened sphere of air might have extended.

Besides, this experiment was not favourably made; since we purposely weighed out somewhat less of the lucid matter, and now and then more of the water, than the precise quantities our calculation supposes.

And lastly, upon search I found, that the grain of icy phosphorus, first put into the spirit of wine, we made use of all this while, was not, tho' after so long a time, totally dissolved; a small fragment, amounting to about an eighth part, if not more, remaining at the bottom of the vial; upon which having poured some fresh spirit of wine, and kept it a while in a little heat, to further the dissolution; that liquor grew very luminous, when dropt into common water: whence it seemed probable, that if the whole grain of icy phosphorus had been dissolved at first in the spirit of wine, it would have impregnated above six hundred thousand times its weight of water, sufficiently to make it shine.

I come

I come now to another way, by which I thought the great subtilty of parts in our noctilucal matter might appear with good advantage. NAT. HIST.

35. We carefully weighed out a small lump of the shining matter, amounting to three grains; and having purposely broke it into several less fragments, perhaps six or seven, we laid them upon a flat-bottom'd glass, that was broader at the top than the bottom, and shallow too, that the matter might be more fully exposed to the free air. This glass we placed in a south window, laying it very shelving, that the liquor to be produced, by resolution in the moist air, might presently run down, and not hinder the free evaporation of the remaining matter. The vessel being thus placed, at about ten of the clock at night, all the fragments of the noctiluca shone briskly, and so continued, till most of them were resolved into other substances; the biggest of them continuing shining, while the others were reduced to such a smallness, that they would scarce have been seen, had not their own light made them visible. But the principal thing in this experiment is, that so little a quantity of noctilucal matter, continued to emit visible fumes, for many more than an hundred and fifty hours; and this with circumstances that made the thing more strange.

For first, the smoke was not only visible, but manifest; and that as well in the night, as in the day.

Secondly, the several parcels of matter did each emit these fumes all at once, as if it were from so many little chimneys.

Thirdly, this smoke was so large, and withal so tenacious, that it would easily retain the form of smoke, at a considerable distance from the bodies that emitted it; so that as I walked in the room, a careless look towards the glass would often discover it; and sometimes it would manifestly appear at a distance, that I estimated to be near a foot from the matter which afforded it.

Fourthly, the motion of the smoke was swift, considering that it had no channel to assist it: and it was not always, nor for the most part, directly upwards, but sometimes horizontal, sometimes downwards, sometimes towards the right hand, and sometimes towards the left; as if the motion of the fumes had been determined by the situation of those parts of the noctilucal fragment, by which they were emitted, and as 'twere discharged. And indeed, I thought, I many times observed a kind of palpitation, or estuation, in the little shining fragments; which I gathered from the apparent great inequality in the plenty of the smoke emitted at several times; all of them, perhaps, within the compass of a minute or two.

And lastly, even in the latter part of the experiment, after the shining matter had been so long exposed to the air, it emitted a strong smell; which seemed to be caused by odorous exhalations, distinct from the visible fumes.



NAT. HIST.

36. Now as I had set the glass, and kept it in a shelving posture; I thereby preserved the saline part of the shining matter, a liquor which I thought fit to examine.

In order to this, I put all the remaining clear liquor, or *Caput mortuum*, into a small concave vessel of well-refined silver. And our liquor being, in this vessel, set upon some small coals and ashes, did not evaporate near so easily, as one would have thought; but turned into an unctuous substance, of a dark reddish colour; wherefore, we placed the vessel upon quick coals, that by their brisk heat they might make the liquor boil, and free it from superfluous moisture. By this means, after a while, it was reduced to a substance, that afforded us a pretty phenomenon. For the boiling liquor crackled like a handful of bay-salt cast into the fire; and whilst these cracklings continued, which they did much longer than one would have expected, they imitated little volleys of shot, not only in the great number of the sounds they made, but in the little flashes that accompanied them; which, when the fire was somewhat increased, were so many, and followed one another so fast, that they appeared to make up a continued flame, pleasant to behold.

37. I had, afterwards, a mind to make some estimate, how far the breaking of the shining matter into fragments, and the conditions of the vessel, contributed to the quick consumption of it. To this purpose, we took a lump of three grains, carefully weighed out, and put it into a small glass funnel, whose upper end was wide and capacious with regard to the lower part, which was exceeding slender, that the noctiluca might have air both above and often below; yet the matter not slide down, till it were so wasted, as to be less than a small pin's head. A vessel of this shape I chose to make use of, that I might catch the liquor, that would be afforded by the deliquation of our icy phosphorus; for which purpose the slender pipe of this funnel was put into the orifice of a small cylindrical vial, and there kept in a quiet place, which was a south window; from whence every night, after I was in bed, I caused it to be brought into my chamber, to see if it continued to shine. By which trials, I found that it remained luminous, and was not yet so wasted, as to fall quite through the funnel into the vial, at somewhat beyond the end of the fifteenth day; so that it continued to shine for three hundred and sixty hours.

What has been hitherto related, may justly make a man reflect, with some wonder, upon the strange minuteness and multitude of parts, that are crowded together in our noctilucal matter; if we consider what a multitude of luminous beams of visible smoke, and of odorable effluvia, so small a quantity of it as three grains, could incessantly afford for two or three hundred hours; leaving, after all this, behind it above three times its weight, (for so we found it to be) of a liquor, which it self was not a cadaverous one; or, what



what it looked like, common water; but was, very probably, impregnated with many saline parts, and not a few capable of shining briskly.

38. I took a little of the consistent noctiluca, and having broke it, and, as its brittleness would permit, spread it here and there upon a piece of folded paper; I lighted that paper at the flame of a candle, and observed, that when the flame reached any little fragment of the shining matter, it would take fire, and burn away in a flashing and very sputtering manner, accompanied with noise; almost like grains of salt-petre, when thrown upon a live coal.

*The inflammability of the noctiluca is self.*

39. I observed also, that if I put pieces of paper, on which I had placed some of these grains of noctilucal matter, upon some embers covered with ashes; before the paper it self took fire, the shining matter would communicate its flame to the contiguous paper.

40. We put a fragment of our shining matter, not amounting to a grain, into half a spoonful, or less, of highly rectified spirit of wine, and kindling that liquor with the flame of a candle, the spirit burned away, as is usual, in a flame partly yellow, but chiefly blue: and though the heat of the silver-spoon, wherein the trial was made, quickly melted the noctilucal matter, and gave it a globular form; yet it continued at the bottom, without manifestly mixing with the vinous spirit, or considerably altering the colour of its flame. But when the spirit of wine was all consumed, without leaving the least phlegm behind it, the last drops coming, when they were actually kindled, to touch the shining matter, they presently set it on fire; but its flame was very different from that of the vinous spirit: for, besides somewhat odd in its figure, its colour was not at all blue, or bluish, but of an intense yellow; and burned so fiercely, and with so vivid a light, that it was surprizing to behold: it also continued to burn for a pretty while, considering the small quantity of the combustible matter. And whilst it burned, it emitted plenty of smoke, that seemed to be darted up to a considerable height. The matter did not burn all away, at once, but left a kind of *Caput mortuum*, which lay in the form of a little cake, partly of a deep yellow, and partly of a fine red. This matter being very bulky, in proportion to what was consumed, I proceeded to burn it after another manner, till there remained only some very few light feces, that seemed to be of the same nature with those in the following experiment.

41. We took a small fragment, not amounting to a grain, of the noctilucal matter, and putting it into a silver-spoon, we cast upon it the sun-beams collected by a small burning glass; whereby it was presently set on fire, and afforded, together with a great deal of smoke, a flame exceeding yellow, and so very fierce and bright, that it was conspicuous, though, the window being purposely set open, the beams of the sun, then in the meridian, were suffered to beat full upon it: a brisk wind also blew upon it without extinguishing it.

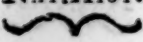
NAT. HIST. At the bottom of the spoon, the expiring flame left a round and broad *Caput mortuum*, consisting of several circles, like those of a sardonix, the largest whereof was white, another yellow, and the third red; all the three colours being pleasant and vivid. Some part of this *Caput mortuum*, being freely touched by the air, appeared combustible; and the rest being left in the spoon, that the air might work upon it, did, for the most part, soon resolve it self *per deliquium* into a liquor, almost as sharp as spirit of salt; the rest remaining a light black feculency; of which, because there was so very little, we could make no trial. But so much matter could not be left unfired, unless something hindered its accension; for when we warily turned over the little cake with the point of a knife; the under part, being, I presume, hot, presently took fire upon the contact of the air, and flamed away, till the matter was almost totally consumed.

42. We put two grains of our dried noctilucal matter into a glass mortar, whose coldness and thickness were able to keep it from being put into any sensible heat, by the operation that was to be performed in it; and consequently, from communicating any heat of its own to the noctilucal matter. This we pretty briskly rubbed in the mortar, with a glass pestle; but though it was thereby brought to shine much more vividly than before, yet it did not take fire; which I was apt to impute to the great coldness of the glass; but at length it took fire, and began to burn away in an actual flame, with much smoke: this, however, did not last so long as might have been expected; probably, because the vessel continued sensibly cold; and perhaps also, because of the narrowness, and depth of it, which somewhat hindered the free access of the air; for some matter, that was taken out on the pestle, seemed to burn better than that which remained in the mortar; and this being extinguished, was once more kindled by trituration; but soon expiring again, could not by the same means be re-kindled, only it shone briskly.

Experiments  
about burning  
other bodies  
with the nocti-  
luca.

43. If our phosphorus be for any time pressed hard between the fingers, or against a board, or some such hard, and not very cold body, it will often feel actually and very sensibly hot; and sometimes the degree of heat will be so vehement, as to scorch the skin, as my venturous assistant found several times to his pain; his fingers being almost covered with blisters, raised on them by handling our shining matter: he also complained to me, that, though he had been often burned on other occasions, yet he found blisters excited by the phosphorus, more painful than others; and he is not the only person, who has complained of finding the burns made with this matter, to be more tedious and difficult of cure than ordinary ones. But, as our noctiluca was not always made of the same matter, nor with care equally successful; so I observed its disposition to burn, and the degrees of heat, to which it would be brought by motion, to be different; upon which account, I did not find, that some



some portions of it, would produce those higher effects of heat, NAT.HIST. that others did; besides, these higher effects gradually differ'd among themselves. 

44. And accordingly, after having in vain tried to fire paper, by pressing and rubbing some of our phosphorus upon it with the blade of a knife; I took a piece of fine paper, and having dry'd, and warm'd it at the fire, I put a little of our noctiluca in a fold of it; and rubbing the paper between my hands, though there was thereby produced a considerable heat, yet it did not reach to what I desired; but continuing a little while to rub the paper, it on a sudden took fire, and blazed out, so that it would have burned my hand, had it not been guarded by a thin glove, which was thereby scorched, and in part shrivel'd up. After the same manner, to make the experiment the more certain, I fired another piece of paper.

45. To try, whether our phosphorus, which appeared not inferior to that of Mr. *Krafft's*, would (as his sometimes did) fire gun-powder; we took a little of our shining matter, and having wiped it dry, we put it upon some dry gun-powder, and with a knife pressed it, and in some sort rubbed it upon the black grains; but found, that though a heat were produced, and sometimes such as would make some of the corns of powder have a bluish flame, yet the mixture would not go off: so that the assistant, to whom I left the care of repeating the experiment, presuming it would not succeed, scrupled not to hold his head over it, that he might the better see what change was made in the mixture; but then, upon a sudden, the powder took fire, and the flame shooting up, burnt his hair.

46. The same person, not long after, bringing me some newly distill'd grains of our noctiluca, covered with some of the shining water, that came over with it, he unluckily broke the glass in his pocket; whereupon the heat of his body, increased by the motion which a long walk had put it into, so excited the matter, fallen out of the broken vial, that it burned two or three great holes in his cloaths.

47. And having put together about half a grain of our dry noctilucal matter, and six times its weight of common flowers of sulphur, they were lodged in the fold of a piece of white paper, which was laid upon a board; and when I had a little bruis'd and rubbed this with the haft of a knife, it shone through the intercepted paper very vividly, but did no more. Wherefore, suspecting that the want of air was the reason why it did not burn, I opened the paper, and found, that as soon as the air had access, it took fire, and furiously burned the paper; and, if I had not been wary, wou'd have burned me too. At another time, in making the same experiment, the ingredients being well rubb'd together in folded paper, though before the paper was displaved and exposed to the air, they did not kindle; yet upon contact with the air, the mixture took fire, and flashed away

NAT. HIST. at once, with a great blaze, like fired gun-powder; only the flame appeared more luminous.

48. The highest effect of the heat of our icy noctiluca, was casually produced by my assistant; who, being desirous to try, whether some that was newly prepared, were good, began to draw letters with it, upon a piece of plank, that had been long used in the laboratory, as part of a stove; and, chancing to press the matter hard upon this board, that the constant heat of the place had brought to an unusual degree of dryness, he found, to his surprize, that he had not only shining, but burning letters; the lucid matter having actually set on fire those parts of the wood, against which he had strongly pressed it.

Whether the  
solid noctiluca  
be an alkali,  
or an acid,  
examined.

49. To examine, particularly, what family, or sort of salts, the saline part of our noctilucal matter either belong'd, or had most relation to, I suffered a little of it to resolve *per deliquium* into a clear liquor, and then made therewith some of the tryals, by which I usually examine what species a salt belongs to. And guessing this liquor by the taste, and the manner wherein it was made, to be somewhat, tho' not altogether, of the nature of spirit of sea-salt; I dropt a little of it upon a convenient proportion of syrup of violets, and found that it turned it not green, but of a fine carnation colour. I found also, that a very little of our liquor, presently destroy'd the blue colour, and not the other of a tincture of *Lignum nephriticum*.

50. I, likewise, put some of this liquor of the noctiluca, upon filings of copper; which, being thoroughly drench'd, and some of them cover'd with it, I expos'd them in a hollow glass for two or three days to the air: and by this means had, without the help of heat, a solution of some of the filings, the colour of which seem'd to partake of green and blue.

51. To make the saline nature of this liquor the more manifest, I put some of it upon powder of red coral, which it presently corroded with noise and froth; and putting another parcel of the same liquor, upon some dry salt of tartar, there immediately ensued a fierce conflict between them, whereby some noise and much froth was produced; so that I thought it needless to waste any more of the noctilucal matter, to make it farther apparent, that our liquor was not, as most chymists would have expected, of an urinous nature, but belong'd to the family of acid salts; and seem'd to be near of kin to that branch of them, to which the spirituous part of common or sea-salt belongs.

Phenomena of  
this phosphorus  
in glasses her-  
metically seal-  
ed.

52. I put some of our dry phosphorus into a clear vial, able to hold about an ounce of water; and having very carefully closed this glass, I laid it aside, and observ'd it to continue to shine for some few days; after which the light manifestly decayed, and soon after quite disappeared; tho' I thought it possible, that it did not expire so soon as it ceas'd to be visible; because the whitish fumes, emitted by the matter, whilst it continued to shine, had cover'd the inside of the glass,

glass, with a kind of whitish foot, that, at length, darkening it, might well hinder a faint light from pervading the vessel, and reaching the eye. But it seems, that the air included with the phosphorus, either had some vital substance (if I may so call it) prey'd upon thereby, or else was by the fumes of the phosphorus, to name no other possible ways, tamed, and rendred at length unfit to continue the particular flame of our noctiluca. NAT. HIST.

53. Yet to pursue the design of making a light more lasting than ordinary, by keeping the matter from the external air; I took some of our noctilucal matter, that came over with the aqueous, from which 'twas not so easily separable, but that I thought it best to leave them together, (in regard that it shone so well, that it might pass for an excellent portion of the aerial noctiluca;) and this we sealed up in a glass-egg (whose bottom had been made flat) and setting it in a place, where it would be frequently in my eye, I observed it from time to time, especially at night, and found it continue to shine for a week, or longer; and this with so little decay of light, that I was surprized, when, coming in the night-time to look upon it, I found it to shine no more; especially since I could not restore any manifest light to it, either by agitation, or by moderately warming the sealed glass, that contained it.

54. After many observations made of the degrees of light, that our icy noctiluca afforded, as 'twere of its own accord, without external heat; I thought fit to try, whether, by the application of a moderate heat of the fire, the light might not be much invigorated, and perhaps the phosphorus it self be brought actually to kindle, even in a close vessel. We took, therefore, some grains of our consistent phosphorus, and put them into a round glass-egg, somewhat larger than an ordinary hen-egg, fitted with a stem of a proportionable bigness, and about two thirds of a foot long. This being hermetically sealed up, the round part of it was warily, and, by degrees, warmed at the fire; and then we instantly removed it into a dark place, where the included matter, not only shone much more vividly than before it was heated, but some portions of it were brought to an actual flame; as appeared both by the radiant splendor of the burning matter, and by the condition of the smoke it emitted; and yet more manifestly, by the intense heat which the flaming part of the matter, communicated to that part of the glass whereto it adhered; for there, the vessel was not to be so much as touched without inconvenience: and when this flame expired, which it did after no long time, the portion of the matter, lately kindled, no more shone or burnt as before; but was reduced to the condition of the rest of the noctilucal matter, together with which it, for a while, retained a considerable degree of light, upon account of the heat it had been expos'd to, over and above that luminousness which ordinarily belonged to it.

This



*NAT. HIST.* This experiment appeared so strange, and was so delightful, that, to gratify the curious, and pursue my own design, 'twas repeated within the compass of a month or two, between twenty and thirty times; the same matter being still kept in the same vessel: tho', by being melted, and in great part sublimed by its frequent approaches to the fire, it was divided into several parcels. But that made the experiment so much the more pleasant, in regard that sometimes more than one, or, perhaps, than two portions of the matter would seem to burn at once. This was looked upon as a very new and scarce credible thing, that a person should be able to bring a body to burn with an actual flame, and for no inconsiderable time, in a glass hermetically sealed, and not large neither. But after we had made many trials, in the above mentioned glass, there happened a phenomenon, which gave me some suspicion, that it was not then actually sealed; tho' it did not appear, but that it had been very well sealed at first, and might continue so during several tryals: for after this suspicion, we used the glass ten or twelve times, or, perhaps, oftener, to make the recited experiment; and after all those, we could perceive no crack or flaw in the ball or stem of the glass; and found it difficult to get in the point of a small pin into a little hole, which we either found, or, by endeavouring to find, made at the apex. However, by the things formerly related, it appeared, that our noctilucal matter would burn with less vent, by great odds, than other fuel known to us; and that a small quantity may be made to burn and shine longer than one would expect. And we were encouraged by what we saw, to hope, that if a more considerable quantity of matter were put into a conveniently shaped glass, and assisted with other friendly circumstances, especially if the luminousness could be a little heightened, it might be rendered useful in ships, and magazines of powder.

I must not omit, that sometimes there appeared a little liquor in this glass, and that the rest of the matter, by the repeated operations of the fire, was turned to a red colour, which it yet retains.

*In water.*

55. I put two grains of our icy noctiluca into a small glass-egg, and pour'd a pretty quantity of water on it: we heated the liquor well, yet without making it boil, and thereby melted the little fragments of solid matter, and made them flow into one liquid mass, that kept it self at the bottom, distinct from the water. This done, we presently removed the glass into a dark place, and pouring out the water, we observ'd, that as soon as the air came to touch the noctilucal matter, it seemed to be kindled into an actual flame, that afforded a very vivid light; which shews, that a kind of fire may be kept under water, as long as one pleases, without sensibly burning; and yet in a moment, upon the bare removal of the water, manifest it self in the form of actual fire. That our shining substance was of this nature appeared evident, because the water, being poured out somewhat too hastily, carried along with it, which I did not intend it should, the whole mass of the noctilucal

lucal matter; and this, by its fall into the silver cup, employed to receive the liquor, was divided into two or three parts, which coming to a fuller contact with the air, blazed out much more than when they were in the glass, and afforded us a delightful spectacle; for the flame burned upon the water with much light and fierceness, and a strange deal of smoke; between whiles sputtering with a noise, like that of salt-petre made to burn upon a live coal. These flames continued upon the water for a pretty while; and after their extinction, looking into the silver cup, we found several flakes of a reddish matter, that lay at the bottom of the water; and the side of the silver cup, that was next to the liquor, looked almost as if fine brick-dust had been strewed upon it.

*In a glass of a particular colour.*

56. We took two or three grains of our matter, and put it into a vial, of an almost spherical figure, capable of holding about twelve ounces of water: this vial was made of fine glass, of a very pleasant colour, participating of those called orange and aurora; but the lucid matter being shut up in it, and carried into a dark room, did not appear through the glass to be considerably altered in colour. And because I imputed this partly to the smallness of the fragment of the phosphorus, with regard to the capacity of the vessel, through which it would give no more than a faint light; I caused the glass to be considerably heated, and then brought it into a dark room; where, as soon as 'twas come, the included matter seemed to be actually flaming, and the trajected rays appeared of an unusual and glorious colour; the light being so considerable, that it made several bodies distinctly visible, at a considerable distance from the glass: and we judged that by the help of it a book of a good print might have been easily read. But this light, which was the greatest we had, till then, produced with our phosphorus, did not last long in its vigour; gradually decaying, till, in a short time, it came to little more than the usual splendor of the noctilucal matter.

*In oil of mace.*

57. The little vial, wherein the noctilucal matter and some oil of mace were included, having been set aside as useless, I afterwards chanced to cast my eye on it; and to try, whether the unsuccessful experiment I had made before, was not of the contingent kind; there being a dark corner in the room, I carried the vial thither; and although it were yet broad day, I was somewhat surprized, upon unstopping it, to find the included matter immediately afford a vigorous light; which put me afterwards upon repeating the experiment at different times, which I did with the like success, without being able to determine the cause of this odd phenomenon.

*Actual fire and flame produced in the solid noctiluca.*

58. We kept in a small receiver, a parcel of consistent noctiluca, in which my assistant told me, he had met with a strange phenomenon, that seemed to appear by chance. This receiver I took into my custody, and pouring out the common water, with which the splendid matter was kept covered, to hinder it from steaming away,

*we*

**NAT. HIST.** we observed no other change, than that, upon the removal of the water, and the contact of the air, the noctiluca would immediately shine, and continue to do so, till we thought fit to extinguish it, by pouring water on it again.

This being done in the morning, I considered on the following night, that the receiver having been kept in the laboratory, which being a very warm place, 'twas but fit, in order to make the trial a fair one, to bring the shining matter to as great a warmth, as it had in the laboratory, where it exhibited the phenomenon I was desirous to see. Having, then, caused the receiver, with the water in it, to be held in a hot place, till the liquor had attained a fit degree of warmth, we poured out the water; and within a minute or two after, had the pleasure to see, that the consistent matter, notwithstanding the wetness that, in probability, the water had left on it, did, upon contact with the air, take fire of it self, not without noise, and burn with a manifest and actual flame. But before we could pour in water to quench the fire, the violence of the flame had broke the receiver, which was thick; and thrown off a piece above half as broad as the palm of one's hand; by which unlucky accident we were hindred from endeavouring to try, whether we could, by repeated experiments, discover the cause of the appearing contingency of this odd phenomenon.

*The way of  
preparing the  
aerial noctilu-  
ca.*

At length we come to give the method of preparing our noctiluca.

But, 1. I will not positively affirm, that the matter I employed is the very same that was made use of by the ingenious *German* chymists in their noctiluca; for some inquisitive men have told me, that the *Germans* mix two or more distillable materials; whereas I employed but one substance capable of distillation. 2. Tho' the foregoing observations were commonly made upon that substance, which, I guess, to be, at least, the chief employed by the *Germans*; yet I first thought, and upon my first trial found, that 'tis possible to make a noctiluca of a dry and pulverable substance, which, for ought I can guess, was never employed by Mr. *Krafft*, or those from whom he had his secret. And besides this second sort of phosphorus, we made a third, which was obtained from a material, that never had been either a part, or an excrement of a human body; nor was mixed with any thing that had been so. 3. To name the matter, tho' ever so explicitly, wou'd not, in my opinion, have sufficed to inform those who wou'd work upon it; for chymists themselves would, in all probability, work, as hitherto, on other occasions, they have done, upon the volatile and saline, which they presume to be the only spirituous and noble parts of the concrete; throwing away the rest as useless and abominable. 4. I think fit to give notice, that having employed the material of our noctiluca, with-



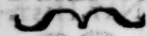
without previous fermentation or putrefaction, tho' it was proceeded with after the same manner, with that whereby we obtained our shining substance; and tho' it afforded a substance, for colour and consistence not unlike our luciferous matter; yet I could not find that it would shine at all. And, indeed, there are so many circumstances that may make the experiment miscarry, that he who shall, at the first attempt, succeed in preparing this liquor, must be a very skilful, or a very lucky operator. Lastly, that it may appear, as well by the very different preparations, as by the different phenomena of the *Phosphorus hermeticus*, and of the aerial noctiluca, that there is a great disparity between those lucid bodies; I shall here add the way we employed to make either the *Phosphorus Balduini*, or some other like it, as it was practised in my furnaces. A dissolution being made of fine white chalk in good spirit of nitre, or clean *Aqua fortis*, it is to be filtered thro' cap-paper; and the clear solution to be evaporated, till there remains a dry substance; with this white calx you are to overlay the inside of some vessel, made of good earth, that will endure the fire, and of a round figure, which is more convenient than that of ordinary crucibles; and to the matter contained in this vessel, you are to give, for about half an hour, or an hour, according to the largeness of it, and other circumstances, a due degree of fire, which 'tis not easy to hit, and which ordinarily requires a conveniently shaped vessel, whereby the flame or heat may be reverberated, till you perceive the matter to have acquired a disposition to retain the light; and then the earthen vessel, which usually ought to be somewhat shallow, and not to exceed many inches in diameter, is to have a cover of fine glass or crystal, carefully cemented on it, to preserve it from its great enemy, the air.

And the  
PHOSPHO-  
RUS BAL-  
DUINI.

We took a large quantity of human urine, that had been for a competent time digested or putrefied. This we distilled with a moderate heat, till the spirituous parts were drawn off; after which, the superfluous moisture also was evaporated, till the remaining substance became of the consistence of a thick syrup, or a thin extract; and this being well incorporated with about thrice its weight of fine white sand, the mixture was put into a strong retort; whereto we joined a large receiver, in great part filled with water. Then, the two vessels being carefully luted together, a naked fire was gradually administered for five or six hours; that all, which was either phlegmatic, or otherwise volatile, might come over first. When this was done, the fire was increased; and at length, for five or six hours, made as strong and intense, as the furnace, a good one, was capable of giving. By this means there came over plenty of white fumes, almost like those that appear in the distillation of oil of vitriol; and when these fumes were past, and the receiver grew clear, they were after a while succeeded by another sort, which seemed in the receiver to give a faint, bluish light, almost like that of little,

The process  
for preparing  
the aerial no-  
ctiluca.

NAT. HIST.



Experiments  
about explo-  
sions,

With the spi-  
rits of nitre,  
and of wine.

burning matches dipped in sulphur. And last of all, the fire being very vehement, there passed over another substance, that was judged more ponderous than the former, because much of it fell thro' the water to the bottom of the receiver; whence being taken, it appeared, by several effects, and other phenomena, to be of a lucid nature\*.

I shall here, for the relation of the subject, add a few experiments, made to shew the nature of explosions.

Having put one ounce of spirit of nitre, so strong, that its fumes made the upper part of the containing glass always reddish, into a bolt-head, with a long neck, able to contain twelve or sixteen times as much; we caused an equal weight of highly rectified spirit of wine to be taken; and a little of it being put to the spirit of nitre, it presently made so strong and quick an explosion, that some

of

\* Dr. Wall tells us, that Mr. Boyle finding, that urine yielded but a very small quantity of phosphorus, impo-  
runed him to look out for some other subject, that might afford it in greater plenty; upon which he caused, in the summer-time, a piece of dry matter to be dug up in the fields, where night-men emptied their vessels; and breaking it in the dark, a great number of small particles of phosphorus appeared therein. This matter the Dr. immediately carried to Mr. Boyle, and Mr. Bilgar, the chymist, went presently to work up by Mr. Boyle's direction; but could make very little or no phosphorus from it, till another material was added thereto in distillation: and then he made it in such plenty, that selling large quantities at six guinea's, or six *Louis d'Or's*, the ounce; he soon became rich, and left England. *Philos. Trans.* N<sup>o</sup>. 314. p. 69.

'Tis very remarkable, what pains and cost the judicious M. Homberg, bestowed upon human excrement, in order to distil from it a fine, clear, limpid oil, without any ill scent; by means whereof, he hoped to fix common mercury into pure silver. After many laborious processes, he, at length, obtained such an oil; but it failed in fixing the mercury. This, however, lead him to discover an excellent phosphorus, which yields its light without any friction, application of heat, or mixture with any other body; and that as well by night, as by day. This phosphorus is a powder made from equal parts of human

dung, and roch alum, mixed together, dry'd and prepared by a particular process, which the author describes at large. The colour of it is black, brown, red, green, yellow, or white, according to the vessel, and the degree of fire used in the preparation. It begins to flame as soon as ever it is exposed to the air, and sets fire to any combustible matter whereon 'tis laid; and must, therefore, be kept in the same glass wherein 'tis made; for to put it out of one vessel into another, or return any parcel of it back into the same, would set it all on fire. See the *French Memoirs*, A. 1711. p. 49—59. and 307—316.

The same author prepared three sorts of phosphorus; one that would set combustible materials on fire, without appearing it self in flame; another, which gives fire and flame like a burning coal; and a third, which would burn and flame like a lighted taper; and these only differ'd according to the degree of fire, and the quantity of alum employed in their respective preparations. The sun's rays, or the moisture of the air, gradually admitted into this powder, would spoil it; and it must, therefore, be kept in a dry, dark place. M. Lemery having successively substituted several materials for the human dung, employed in this preparation, found, that almost any animal, or vegetable material, would serve in its stead; as the yolks of eggs, wheat-flower, &c. with different proportions of alum. See *Memoir. de l'Acad.* A. 1714. p. 520.

of it flew out of the glass, and hit against the ceiling of the room; and falling upon the face of him who held the glass, made him think fire had fallen thereon; but ordering him to proceed more warily, he put into the bolt-head only part of a spoonful of spirit of wine at a time; yet at many of these affusions, there would be a great noise, as of an ebullition produced, tho' no quantity of froth; and this was accompanied with so great a heat, that I could not hold the glass in my hand; when immediately there would issue out a large red smoke, to which, when I caus'd a lighted candle to be held, tho' at half a foot distance from the top of the bolt-head, it would presently take fire, and burn at the top of the glass, like a flame at the upper end of a candle; till I caus'd it to be blown out, that fresh spirit of wine might be poured in; which being all mixed with the other liquor, the heat and conflict ceased. To shew that the noise and ebullition produced in this mixture, is not unattended with a brisk, expansive, or explosive motion, we put an ounce of the strong spirit of nitre above-mentioned, into a moderately large bolt-head, furnished with a proportionable stem, over the orifice, whereof we strongly tied by the neck a thin bladder, out of which most part of the air had been squeez'd, and into which we had conveyed a small vial, containing a little highly rectified spirit of wine. Then this vial, that before was closed with a cork, being unstopp'd, without untying or taking off the bladder; a small quantity, by guess not a quarter of a spoonful, of the spirit of wine, was made to run down into the spirit of nitre; where it presently produced a great heat and commotion, and blew up the bladder as far as it would well stretch; filling also the stem and cavity of the glass with very red fumes; which presently after forced their way into the open air, in which they long continued to ascend in the form of an orange-coloured smoke.

I have more than once taken strong oil of vitriol, and common oil of turpentine, and warily mixed them in a certain proportion, by shaking them very well together; whereupon has ensued so furious an agitation of the minute parts of the mixture, and so vehement, or sudden an expansion, or explosion, as did not only seem strange to the spectators, but would have proved dangerous too, if I had not taken care before hand, that the trials should be made in a place, where there was room enough; and that even the operator, who shook the vessel, should stand at a convenient distance from it.

We put two ounces of powder'd sal-armoniac into a large glass tube, hermetically sealed at one end, and into the same, a slender glass pipe, furnished with two ounces of oil of vitriol, which was so placed, that at pleasure we could make the liquor run out into the larger tube, which was clos'd exactly, so that nothing might get in or out. My design was, that this instrument should be so warily inverted, that the operator might get out of the way, and the oil of vitriol

*With the oils  
of vitriol and  
of turpentine.*

*With two bo-  
dies actually  
cold sal-ar-  
moniac and oil  
of vitriol.*



NAT. HIST. falling slowly upon the sal-armoniac, shou'd, without causing any heat, produce an explosion not dangerous to the by-standers. But in my absence the operator, not staying for particular directions, rashly inverted the instrument, without taking care to get away; whence it happened, that as soon as ever the contain'd liquor, being too plentifully poured out, came to work on the sal-armoniac, wherewith it usually produces cold, there ensued an expansion or explosion, so surprisingly great, that with a vehement noise the glasses were broken into a multitude of pieces, and much of the mixture thrown up, with violence, against the operator, whereby his hat was struck off, and his face, especially about his eyes, much hurt; whence, immediately, tumors, extremely painful, were produc'd; which might, also, have been very dangerous, had I not directly caused the parts affected, to be bath'd with a solution of *Saccharum Saturni* in fair water; by which means, within an hour or two, the pain that had been so raging, was taken away, and the fretting oil kept from so much as breaking the skin of the tumors that it had rais'd. At another time we made a like tryal in a safer way, by tying a bladder so to the top of a bolt-head, into which we had, beforehand, put the sal-armoniac, that by warily moving the bladder, whence the air had been pressed, we cou'd make some of the sal-armoniac, we had lodged in its folds, to fall upon the liquor, with which it presently made an explosive mixture that quickly blew up the bladder\*.

\*It may appear surprizing, that two cold liquors being put together should immediately flame, or set fire to gun-powder; yet any acid spirit highly rectified, being mix'd with the essential oil of an aromatic plant, well freed from acid, and thereby render'd partly sulphureous, will do this. But, as *M. Homberg* observes, the oils of *European* plants will not serve for the experiment, but it requires those of hotter climates, viz. oil of cinnamon, cloves, mace, &c. Nay, if even these be adulterated with the other, or any way sophisticated, 'twill frustrate the tryal; which may, therefore, prove a criterion, whereby to examine them. *Memoir. de l'Acad. A. 1701. p. 1724.*

*Dr. Stave* furnishes us with many curious experiments relating to this subject. See *Philos. Collect. N<sup>o</sup> 3. p. 48. Philos. Trans. N<sup>o</sup> 150. p. 291. N<sup>o</sup> 213. p. 200.*

But let us hear *Sir Isaac Newton* upon this subject. "When oil of vitriol, (says he) is drawn off from its weight of nitre, and from both ingredients, a compound spirit of nitre is distill'd, and

"two parts of this spirit are poured upon  
"one part of oil of cloves, or caraway-  
"seeds, or of any ponderous oil of vegetable or animal substances, or oil of turpentine, thickened with a little balsam  
"of sulphur, and the liquors grow so  
"very hot in mixing, as presently to send  
"up a burning flame; does not this very great and sudden heat argue, that  
"the two liquors mix with violence, and  
"that their parts in mixing, run towards  
"one another with an accelerated motion, and clash with the greatest force?  
"And is it not for the same reason, that  
"well rectified spirit of wine, poured on  
"the same compound spirit, flashes; and  
"that the *Pulvis fulminans*, composed of  
"sulphur, nitre, and salt of tartar, goes  
"off with a more sudden and violent explosion than gun-powder; the acid spirits of the sulphur and nitre rushing  
"towards one another, and towards the  
"salt of tartar, with so great a violence, as  
"by the shock to turn the whole, at once,  
"into vapour and flame? — When  
"a dram of the compound spirit of nitre

"was

“ was poured upon half a dram of oil of  
 “ caraway seeds *in vacuo*, the mixture im-  
 “ mediately made a flash like gun-pow-  
 “ der, and burst the exhausted receiver, a  
 “ glass six inches wide and eight deep;  
 “ and even the gross body of sulphur  
 “ powder’d, and with an equal weight of  
 “ iron filings and a little water, made into  
 “ paste, acts upon the iron, and in five or  
 “ six hours grows too hot to be touched,  
 “ and emits a flame. And by these experi-  
 “ ments, compared with the great quan-  
 “ tity of sulphur with which the earth  
 “ abounds, and the warmth of the interior  
 “ parts of the earth, and hot springs, and  
 “ burning mountains, and with damp, mi-  
 “ neral coruscations, earth-quakes, hot suf-  
 “ focating exhalations, hurricanes, and  
 “ spouts; we may learn, that sulphure-  
 “ ous steams abound in the bowels of  
 “ the earth, and ferment with minerals,  
 “ and sometimes take fire with a sudden  
 “ coruscation and explosion; and if pent  
 “ up in subterraneous caverns, burst the  
 “ caverns with a great shaking of the  
 “ earth, as in springing of a mine. And  
 “ then the vapour generated by the ex-  
 “ plosion, expiring thro’ the pores of the

“ earth, feels hot, and suffocates, and  
 “ makes tempests and hurricanes, and  
 “ sometimes causes the land to slide, or  
 “ the sea to boil, and carries up the water  
 “ thereof in drops, which, by their  
 “ weight, fall down again in spouts.  
 “ Also some sulphureous steams, at all  
 “ times when the earth is dry, ascending  
 “ into the air, ferment there with nitrous  
 “ acids, and sometimes taking fire, cause  
 “ lightning, and thunder, and fiery me-  
 “ teors. For the air abounds with acid  
 “ vapours, fit to pomote fermentations,  
 “ as appears by the rusting of iron and  
 “ copper in it, the kindling of fire by  
 “ blowing, and the beating of the heart by  
 “ means of respiration. Now the above  
 “ mentioned motions are so great and  
 “ violent, as to shew, that in fermentati-  
 “ ons the particles of bodies, which almost  
 “ rest, are put into new motions by a  
 “ very potent principle, which acts upon  
 “ them only when they approach one ano-  
 “ ther, and causes them to meet and clash  
 “ with great violence, and grow hot with  
 “ the motion, and dash one another into  
 “ pieces, and vanish into air, and vapour,  
 “ and flame.” *Newton. Optic. p. 353—355.*



# EXPERIMENTS AND OBSERVATIONS UPON THE SALTNESS of the SEA.

**T**HE cause of the saltness of the sea appears, by *Aristotle's* writings, to have exercised the curiosity of naturalists before his time; since which, his authority has, for many ages, sway'd the generality into his opinion; till of late, some learned men took the boldness to question the common doctrine: and from that time, the controversie has been kept on foot, and, for ought I know, will be so, as long as 'tis argued, on both sides, but by dialectical arguments. I shall here, therefore, deliver some particulars about the saltness of the sea, obtained by my own tryals, where I was able to make them; and where I was not, from the best relations I could procure.

*The saltness  
of the sea,  
whence?*

First then, *Aristotle* and his followers, derive the saltness of the sea from the aduſion of the water by the ſun-beams; but it has not, I believe, been found, where no ſalt or ſaline body was diſſolved in, or extracted by water, expoſed to the ſun, or other heat, that any ſuch ſaltneſs is produced. There are many lakes and ponds of freſh water to be met with, even in hot countries, where they lie expoſed to the action of the ſun. And as for other heat, by diſtilling off common water in large glaſs bodies, till all the liquor came over, I found, at the bottom, not above a three thouſandth part of ſalt, among a little white earthy ſubſtance. And tho' there had been a greater quantity of ſalt, which, perhaps, may be met with in ſome waters, I ſhould not have concluded it generated out of the water by the action of the fire; becauſe I have, by ſeveral tryals, found, that in many places, common water, before ever it is expoſed to the heat of the ſun,



sun, or other fire, has in it a saltness, easily discoverable, of the nature of common or sea-salt. NAT. HIST.

But some champions for *Aristotle's* opinion alledge experience for it; vouching the testimony of *Scaliger* to prove, that the sea tastes saltier at the top, than at the bottom; where the water is affirmed to be fresh. *Whether the sea be saltier at the top than at the bottom?*

'Tis true indeed, having often observed sea-salt dissolved in water, usually to begin its concretion, upon the absence of the superfluous liquor, I think it not impossible, that, sometimes, in very hot climates, the sea may taste more salt at the surface, than at some distance beneath it. But considering with how great a proportion of the salt common water is impregnated, before it suffers saline concretions to begin; and how far short of that proportion, the salt contained in the sea water is, being found about *Holland*, scarcely as one to forty; it seems not likely, that *Scaliger's* observation was well made; and it must be very unlikely that it should generally hold, if the saltness of the superficial parts of the sea, be compared with that of the lower.

Yet I do not build my opinion wholly upon this argument, that salt being a heavier body than water, must necessarily communicate most saltness to the lowest parts.

For though this be plausible, yet water is a fluid, the restless agitation of whose corpuscles, makes them, and the particles they carry with them, perpetually shift places; whereby the same parts come to be sometimes at the top, and sometimes at the bottom. This, therefore, being considered, with the peculiar disposition of dissolved sea-salt, to begin its coagulation upon the surface of the water, it may render the argument suspected; and the rather, because that in metalline and other tinged solutions, I have not usually observed the upper part of the liquor to be manifestly deeper coloured than the lower; though between metalline bodies and their menstria, the disproportion of specific gravity usually far exceeds that which I have met with, between sea-salt and common water.

'Tis urg'd out of *Linschoten*, that wanting fresh water near *Goa*, they make their slaves fetch it from the bottom of the sea. But were this strictly true, it wou'd not universally follow, that all the water at the bottom of the sea is fresh; since in other parts the contrary has been found by experience. Springs of fresh water may happen in some parts of the surface of the earth, covered with the sea, as they do in innumerable vallies, and other places of the terrestrial surface: not to mention those springs that often appear upon a low ebb of the sea. The curious *Hungarian* governor, who gives us an account of the wonderful waters in his country, relates, that in the river *Vagus*, which runs by the fortress *Galgotium*, the veins of hot water spring up at the bottom of it. And I have been assured by more than one learned eye-witness, that there is a place upon the

*Nea-*

NAT. HIST. *Neapolitan* coast, where they observed the water to spring up hot beneath the surface of the sea; so that one of them thrusting in his hand and arm somewhat deeper, found an offensive degree of heat therein.

But as to the particular case of *Goa*, I inquired of a great traveller, and a man of letters, who having lived in that city, and the neighbouring places, gave me a pertinent account of it. He tells me, that the divers do not now think it needful, to fetch their fresh water so low as from the bottom of the sea; and that by the little depth, whence he caus'd it to be taken up, he judg'd it did not come so much from any fresh water springs, rising at the bottom of the sea, as from a small river, which, not far from thence, runs into the sea; with such a conjuncture of circumstances, that the fresh water yet keeps it self tolerably distinct and potable, though not very good.

I might also pretend to a clear experimental demonstration of the contrary to what *Scaliger* delivers, from the testimony of the learned *Patricius*; who affirms, that being upon the sea near *Candia*, he did, in the company of a *Venetian* magistrate, *Moccenigo*, let down a vessel to the bottom of the sea, where, by the help of a contrivance, it was unstopp'd, and filled with water; which being drawn up, was found to be not fresh, but salt. However, I shall confirm the saltness of the sea at the bottom, by some less exceptionable observations.

The first is, that of the person who, by the help of an engine, cou'd stay a considerable time at the bottom of the sea; of whom I learn'd, that the water had as salt a tast there as at the top.

The next observation I obtained by means of a great traveller into the *East* and *West-Indies*, who having seen the famous pearl-fishing at *Manar*, near the great cape of *Comori*, was assured by the divers, that the ocean there was salt at the bottom. And the same person being asked about the saltness of the sea, in a certain place under the torrid zone; which, by the relation of a traveller, I was inclin'd to think, abounded extraordinarily with salt; he affirmed, that not only the divers declared to him, that the sea was there exceeding salt at the bottom, but brought up several hard lumps of salt from thence; whereof the fishermen and others made use to season their meat, as himself also did; which yet we may ascribe not only to the plenty of salt already dissolved in the water, but to the greater indissolubility that some sorts of salts have, to be dissolved in that liquor. And lastly, meeting with an inquisitive engineer, who had many opportunities to make observations in deep waters; I desired him to take a certain copper vessel of mine, furnished with two valves opening upwards, and let it down at sea; but he told me, I might save my self the trouble, for that with a tin vessel, very little differing from mine, he had, near the streights of *Gibraltar*, fetch'd up sea-water from the depth

depth of about forty fathoms, and found it to be as salt in tast, as the water near the surface. NAT. HIST.

These observations may suffice to shew, that the sea is salt at the bottom, in those places where they were made; yet I thought it was not fit to acquiesce in them, but rather endeavour to satisfy my self, by the best trial I could procure to be made with my copper vessel, what saltness is to be found in the water at the bottom of our seas, when examined by weight, and not by tast; and in order thereto, having delivered the above-mentioned instrument to the engineer, when he was going to sea; he sent me, together with it, two bottles of sea-water, taken up, the one at the top, and the other at the bottom, fifteen fathoms deep. The colour and smell of these two waters were somewhat different; but when I examined them hydrostatically, by weighing a roll of brimstone first in one, and then in the other, I scarce found any sensible difference in their specific gravities. So that if the degree of the saltness of sea-water, may be safely determined by its greater or lesser weight; then, so far as this single experiment reaches, the saltness is equal at the top and bottom of the sea.

And as to those very few places, if really there have been any, where the sea-water was found fresh at the very bottom; I think one may ascribe the tast of the water, to the bubbling up of springs of fresh water, at, or near enough to, those very places. I know this has the appearance of a paradox; since it may seem altogether unlikely, that so small a stream of water as can be afforded by a spring, should be able to force its way up, against the resistance of so vast a weight, as that of the incumbent sea; especially since this liquor, by reason of its saltness, is heavier *in specie* than fresh water. *That springs of fresh water may rise at the bottom of the sea.*

But persons acquainted with hydrostatics, know, it matters not how great a quantity of liquor, lies laterally higher than the lower orifice of the pipe or channel, that gives passage to the fluid to be impell'd up into it; provided the upper surface of that in the channel or pipe, have a sufficient perpendicular height, with regard to that of the stagnant water; for no more of all this fluid will hinder its ascent, than the weight of such a pillar of it, as is directly incumbent thereon. So that, considering the channel wherein a spring runs into the sea, as a long inverted syphon; if that part either of the neighbouring, or more distant shore, whence the spring or river takes its course, be a hill, or a rock, or any other place considerably higher than that part of the bottom of the sea, at which the channel, which conveys fresh water, terminates; that liquor will issue out, notwithstanding the resistance of the ocean.

At once to illustrate and prove this paradox, I took a vessel of a convenient depth, and a syphon of a proportionable length, both of them glass, that their transparency might permit us to see all that passed within them. Into the larger vessel we put a quantity of sea-water, *Illustrated and proved by experiment.*



NAT. HIST. water, and into the longer leg of the syphon, which was inverted, we poured a convenient quantity of fresh water; and kept it from running out at the shorter leg, by stopping the orifice of the longer with the finger: then this syphon being so placed in the larger vessel, that the orifice of the shorter leg was far beneath the surface of the salt-water; and the superficies of the fresh water in the longer leg, a pretty deal higher than that of the surrounding salt-water; we unstopped the orifice of the upper leg, whereby the water in the syphon tending to reduce it self to an *Equilibrium* in both legs, the water in the upper, being much higher and heavier than that in the other, by subsiding, drove away the water in the shorter leg, and made it spring out at the orifice thereof, in spite of the breadth and specific gravity of the salt-water. And this impulse of the fresh water upwards, lasted as long as the surface of that water in the longer leg, retained its due height above that of the surrounding sea-water.

And to make this experiment the more visible, I perform'd it with fresh water, tinged with brazil or log-wood; but to prevent its being objected, that thereby the specific gravity of the liquor would be altered or increased; I afterwards chose to make it with claret wine, which, being lighter than common water, and of a conspicuous colour, is very convenient for the purpose. When placing the orifice of the shorter leg, at a convenient distance below the surface of the sea-water, 'twas pleasant to observe, how upon the removal of the finger that stopp'd the orifice of the longer, the quick descent of the wine contained in it, impell'd the colour'd liquor in the shorter leg, and made it spring up at its orifice into the incumbent sea-water, in the form of little red clouds, and sometimes of very slender streams. And as this shorter leg of the syphon was raised more and more towards the surface of the water, so there issued out more and more wine at the orifice of it; the liquor in the longer leg proportionably subsiding, yet continuing manifestly higher than the surface of the salt-water, than which it was *in specie* lighter.

The true cause  
of saltness in  
the sea.

The true cause of the saltness of the sea, I, with the moderns, ascribe to the salt that is dissolved in it: but I take that saltness to be supplied, not only from rocks, and other masses of salt, which at the beginning were, or in some places may yet be found, either at the bottom of the sea, or at the sides, where the water can reach them; but also from the salt, which the rains, rivers, and other waters, dissolve in their passage through many parts of the earth; and at length carry along with them into the sea. For 'tis manifest, that several countries afford salt-springs, and other running waters, that at length terminate their course in the sea; and I have sometimes suspected, that very frequently the earth it self is impregnated with corpuscles, or at least, rudiments of common salt; though no such

fuch thing be vulgarly taken notice of. For eminent chymifts, NAT. HIST.  
affirm themfelves to have found a confiderable quantity of an exceeding faline liquor, upon the evaporation of large quantities of fome waters: and a large quantity of common falt, is ufually found in the refining of falt-petre; a falt, which, as experienced writers teach, almoft every fat earth, kept from the fun and rain, and from fpend-  
ing it felf in vegetation, will afford.

And fince the earth abounds with common falt, in many more places than are ufually obferved; and fince 'tis probable, that by maturation, or otherwife, falt may daily grow in the earth; 'tis obvious, that our common terreftrial falt being diffolved, may fuffice to make the fea-water brackifh: the ocean too, may receive fupplies of falt from rocks and fprings latent in its own bofom; which, poffibly, is one reafon, why fome feas are fo much falter than others.

And as our common terreftrial falt, may be communicated to the fea in plenty enough to impregnate it with as much faltnefs as we obferve it to have; fo the difference between that falt and fea-falt feems not too great, to be derived from thofe changes that the terreftrial falt may be liable to, when it comes into the fea. For that the marine falt, and the terreftrial, very well agree in the general, may be argued from the refemblance in fhape, taft, &c. obferved between the grains produced by expofing each of them, in a diftinct glafs, to fuch a heat, as may flowly carry off the fuperfluous moiifture, and fuffer them to coagulate into cubical grains: and the lefs differences that may be met with between thefe two falts, may well be fupposed producible by the plenty of nitrous, urinous, and other faline and bituminous bodies, that by land-floods, and otherwife, are from time to time carried into the fea; and by feveral things that happen to it there, efpecially by the various agitation 'tis put into by tides, winds, currents, &c.

We may juftly be the more careful to determine, whether the faltnefs of the fea-water proceeds from common falt diffolved in it, becaufe if it appeared to be fo, we might the more hopefully attempt to obtain, by diffillation, fweet water from fea-water; fince, if this liquor be made by the bare diffolution of common falt in the other, 'tis probable, that a feparation may be made of them, by fuch a heat, as will eafily raife the aqueous parts of fea-water, without raifing the faline. And fuch a method of feparating frefh water, from that which was falt, would make our doctrine of ufe, and be very beneficial to navigation, and confequently to mankind. For in long voyages, 'tis but too common to be liable to hazards and inconveniencies, for want of frefh and fweet water; whereby men are fometimes forced to drink corrupt, brackifh water, which gives them feveral difeafes, particu'arly the fcurvy, and the dropfic. And fea-men receive fo many other inconveniencies thro' the want of frefh water, that, to prevent, or fupply it, they are often forced to change their courfe, and

*To make fea-  
water frefh by  
diffillation.*

NAT. HIST.

fail some hundred of miles to a dangerous coast, by which means they often lose the benefit of their trade-winds, and frequently of their voyage. And these are inconveniencies which might be, in good measure, prevented, if potable, and tolerably wholesome water, could be obtained by distillation, in the midst of the sea it self; to serve the sailors till they could be supplied with natural fresh water. To attempt this, I took some *English* sea-water, whence I was able to separate betwixt a thirtieth and fortieth part of dry salt; and having distilled it in a glass-head and body, with a moderate fire, till a considerable portion of it was drawn over, we could not discern any saltiness in it by the tast; besides, I found it specifically lighter than such water as is daily drunk by persons of quality at *London*. I afterwards exposed it to a more chymical examination, and did not by that find any thing of sea-salt in it; tho' I have several times, by the same way, manifestly discovered a saltiness in inland-waters, that are used for sweet. If I would have employed a stronger heat, and vessels larger and lower, or otherwise better contrived for great distillation, I might, in a shorter time, have obtain'd much more distill'd water: but whether such liquors will be altogether so wholesom, experience must determine. Yet that sea-water, distill'd even in no very artificial way, may be so far wholesom, as not soon to be sensibly noxious, may be gathered from the testimony of that famous navigator Sir *R. Hawkins*, who commanded a fleet, in the *Indies*, for queen *Elizabeth*. For he, in the judicious account he gave of his voyage, wherein they were distressed, even in the admiral's ship, for want of fresh water, has this memorable passage. "Altho' our fresh water had fail'd us many days  
 " (before we saw the shore) yet with an invention I had in my ship,  
 " I easily drew out of the water of the sea sufficient quantity of fresh  
 " water, to sustain my people, with little expence of fuel; for with  
 " four billets I still'd a hoghead of water, and therewith dressed meat  
 " for the sick and whole. The water so distill'd we found to be  
 " wholesom and nourishing."

Liquors distilled from sea-water, chymically examined.

And because the potableness of sea-water may concern the healths and lives of men, I shall here add two or three observations I made upon those few distill'd liquors, I had occasion to draw from sea-water. Having then, upon some of the distill'd liquor, dropt a little oil of tartar *per deliquium*, I perceiv'd no clouds at all, or precipitation to be made; tho' a small proportion of that liquor being dropt into the undistill'd sea-water, would presently trouble and make it opake; and, tho' slowly, strike down a considerable deal of a whitish substance. I found, also, that a very small proportion of an urinous spirit, such as that of sal-armoniac, would produce a whitish and curdled substance in sea-water, before it was exposed to distillation, but not in the liquor drawn from it: which argued, that there were but few or no saline particles of sea-salt ascended with the water; otherwise these alcali-

\*

zate



zate and urinous falts would, in all likelihood, have found them out, and had a vifible operation on them. I farther remember, that when the diffillation was made in glafs veffels, with an eafie fire; not only the firft running, but the liquor that came over afterwards, was not perceived to be brackifh, but good and potable. And by a hydroftatical tryal, I found our diffill'd fea-water to be lighter in *specie* than common conduit water, but heavier than diffill'd rain-water.

To return, it may be objected, that if the terreftrial falts, carried by fprings, rivers, and land-floods, into the fea, were the caufe of its faline tafte, thofe waters themfelves muft be made falt by it, before they arrive at the fea. But this objection will not reach the fprings and rivers of falt-water, that in feveral places, either immediately or mediately difcharge themfelves into the fea. However, I take it to be only a partial caufe, that contributes to the degree of faltnefs obferved in the ocean, where this imported falt may join it felf with that it finds there already, and being detained by it, contribute to the brinefs of the water.

If it be urg'd, that from hence the fea muft increafe in faltnefs, I may fufpend my answer till it appear by competent obfervation, that it does not; which, I think, we have no tryals to warrant. And if the matter of fact were certain, I think it poffible to give a farther answer, and fhew probable ways, how fo fmall an addition of falt may be difpers'd by nature, and kept from increafing too much.

But the tafte of fea-water is not fuch a fimple faline tafte, as fpring-water would receive from *Sal gemma*, or fome other pure terreftrial falt diffolved in it; but a bitterifh one, that muft be derived from fome peculiar caufe which authors commonly overlook. I am not affur'd by any obfervations of my own, that this reffels from a purely faline tafte, is likely to be of the very fame kind, and to be equally met with, in all feas. The caufe both of the bitternefs and faltnefs of the fea-water, is faid to be aduft and bituminous exhalations afcending out of the earth into the fea. Now, that there is abundance of actual falt in the fea-water, to give the faline tafte and weight it has, the falt, that the fun, in many places, plentifully feparates from the faltlefs waterifh parts, fufficiently manifefts. But as to the bitterifh tafte, I think it no eafie matter to give a true account of it; tho' I am apt to afcribe it to the operation of fome general agents upon the vaft ocean, and to the alteration that the falt receives from the mixture of fome other things, among which bitumen may be one of the principal.

*The caufe of  
the bitternefs  
in fea-water.*

But tho' in fome places of the fea there are confiderable quantities of bitumen, or bituminous matter; yet I dare not derive the bitternefs of the fea wholly from bituminous exhalations, but in good part, at leaft in fome places, from the liquid and other bitumen, that is imported by fprings and other waters into the fea; of which we have an eminent inftance in *Barbadoes* tar, according to the relation I had of it from an inquisitive gentleman, who is one of the chief  
planters

NAT. HIST.

planters of the island, and took pleasure to observe this liquid bitumen to be carried in considerable quantities from the rocks into the sea: and I think it possible enough, that some of the springs which rise under the surface of the sea, may carry up with them bituminous matter, contributing to make the saltiness of the sea degenerate; as I have suspected, that in some places the sulphureous exhalations, and other effluvia from the submarine parts of the earth, may, sometimes, contribute to change the saline taste of the sea-water: for not only sulphureous steams, but sometimes actual flames, have broken through from the lower parts of the sea to the upper; and I have sometimes made, by art, a rude imitation of that phenomenon. Some experiments, also, of my own, and other inducements, have persuaded me, that, sometimes, sea-salt does not obscurely participate of combustible sulphur. But as the taste of the sea-water is not in all parts of the ocean uniform, it might suffice to take notice in general, that this difference may, in some measure, be caus'd by adventitious bodies of several kinds; of which 'tis probable, that in different places the sea-water variously partakes. And not to mention here the fragrant smell of violets, which has by several, and particularly by an eminent person, of whom I enquired about it, been observed, in some hot countries, to proceed from sea-salt; I have many other reasons to think, that it is usually no simple salt, nor free from mixture. For by more ways than one, and particularly by cohobating it from its own spirit, we have obtained a dry sublimate, which seemed to be a compounded body.

And I have suspected, that the various motion of the sea, and its being exposed to the action of the air and sun, may contribute to give it a taste other than saline; since sea-salt, by being barely expos'd for many months to the air, and sometimes, perhaps, put into a gentle agitation by a digestive heat, I found acquired a very different taste from the simple solution of sea-salt in common water.

It appears, also, by what I have learned from navigators, about the manifest various colours, and other qualities of the different parts of the sea, that 'tis not every where of such an uniform substance as men vulgarly imagin; and that vast tracts of it are imbued with stupendous multitudes of adventitious corpuscles, which, by several ways, diversifying its parts, keep it from being a simple solution of salt. And because 'tis generally thought, that the sea-water is, by reason of the salt it abounds with, uncapable of putrefaction; I will add, that having kept a quantity of sea-water, which I had caused to be purposely taken up between the *English* and *French* shores, in a good new rundlet, a place where the summer sun beat freely from, it did, in a few weeks, acquire a strongly fetid smell. But a navigator of my acquaintance, having often sailed in the *Indian* and *African* seas, told me, that being once, tho' it was in the month of *March*, becalmed, in a place, for twelve or fourteen days, the sea, for want of motion, and by reason of the heat, began to stink; so that, he thinks, if the calm had continued

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much

much longer, the fench would have poisoned him. They were freed from it as soon as the wind began to agitate the water, and broke the superficies; which also drove away shoals of the sea tortoises, and a sort of fish, that before lay basking on the top of the water. NAT.HIST.

And Sir *R. Hawkins* takes notice; that "were it not for the moving of the sea by the force of winds, tides, and currents, it would corrupt all the world. The experience I saw, says he, in the year 1590, lying with a fleet about the islands of *Azores*, almost six months, the greatest part of the time we were becalmed; with which all the sea became so replenished with several sorts of gellies, and forms of serpents, adders, and snakes, as seemed wonderful; some green, some black, some yellow, some white, some of divers colours, and many of them had life; and some there were a yard and a half, and two yards long; which, had I not seen, I could hardly have believed. And hereof are witnesses all the company of the ships which were then present; so that hardly a man could draw a bucket of water clear of some corruption. In which voyage, towards the end thereof, many of every ship fell sick of this disease, and began to die apace; but that the speedy passage into our country, was a remedy to the crazed, and a preservative for those that were not touched."

As to the various degrees of the sea's saltness, authors are silent; only a few navigators tell us, they observe some seas to have a more, and others a less saline taste. Various degrees of saltness in different parts of the sea.

To gain, therefore, some light in this matter: to a learned man who was to sail to places of different latitudes in the torrid zone, I delivered a glass instrument, fitted, by the greater or less emersion of the upper part, to shew, accurately enough for use, the greater or less specific gravity of the salt-water it was set to swim in. This he put, from time to time, into the sea-water, as he sailed towards the *Indies*; whence he wrote me word; that "he found, by the glass, the sea-water to increase in weight, the nearer he came to the line; till he arrived at a certain degree of latitude, as he remembers, about the thirtieth; after which, the water seemed to retain the same specific gravity, till he came to *Barbadoes* or *Jamaica*."

Another observation I obtained, by inquiry, of an ingenious person, and a scholar, at his return from the *East-Indies*; who affirm'd to me, that he, and a gentleman of my acquaintance, took up bottles full of sea-water, under the equinoctial, and off the cape of *Good Hope*, which lies in about 34 degrees of south latitude; and found the waters of these distant parts of the ocean, to be of the same weight.

In a letter from *Musilapatan*, on the gulf of *Bengale*, in the *East-Indies*, written by Sir *William Langhorn*, who is intrusted with the care of the *English* factories in those parts, I have the following account:



NAT. HIST. count: "Off the cape, in 37 d. 00 m. south latitude, I took up  
 "some sea-water, and kept it till I came to the line again; and  
 "then compared it with the water there; filling the same bottle  
 "again to the same height by a mark, and found it exactly of the  
 "same weight."

Inquiring of an observing person, who had been at *Mosambique*, which is thought to be one of the hottest places in the world, whether he did not there find the sea to be more than ordinarily salt? he answered me, that, coming thither in a great carack, when he returned from the town to the ship, he observed near two hands breadth of the vessel risen above the ordinary part, to which it used to sink; so that he took notice of it to the captain, as fearing that part of the lading had been, by stealth, carried to shore: but the pilot, who had made thirteen or fourteen voyages to the *Indies*, assur'd him, what he had observed about the ship was usual in that place, where the tast discovered the water to be exceeding salt.

Nor need we scruple to allow, that some sea-waters may be very much more impregnated with salt than ours; for water will naturally dissolve, and retain a far greater proportion of salt, than that which is commonly met with in the sea. A thirty fifth, a thirtieth; or, at most, a twenty fifth part of salt, will make water more saline, than it is found in many seas: and a friend of mine, who is master of a salt-work, informed me, that the water of his springs affords him a twelfth part of good white salt; and that another spring not far off, yields no less than an eighth part.

Experiments  
 to discover the  
 weight of sea-  
 water.

To come to my own experiments that I made about the gravity of sea-water, which I order'd to be taken up, some at the depth of about fifteen fathoms near our shore, and some in another place of the channel between *England* and *France*.

We took a vial, with a long and strait neck, and having counter pois'd it, we filled it to a certain height with common conduit water we noted the weight of that liquor; which being poured out, the vial was filled to the same height with sea-water, taken up at the surface; and by the difference between the two weights, the sea-water appeared to be about a forty fifth part heavier than the other.

We carefully counterpois'd a piece of sulphur in the upper sea-water; it weigh'd  $\frac{3}{5}$  s.  $10\frac{1}{2}$  gr. and being also weigh'd in sea-water fetch'd from the bottom, it gave us the same weight; which shewed those two waters to be of the same specific gravity. We then weigh'd the same sulphur in common conduit water, and found it  $\frac{3}{5}$  s.  $15\frac{1}{2}$  gr. By which it appeared, that the sea-water was but about a fifty third part heavier than this water: which such a difference from the proportion found in the former way of trial, that I could not imagine what to attribute it to; unless the sea-water, by long standing in a vessel, which, though covered, was

exposed

expos'd to the hot sun, might both have been rarified, and have had some separation made of its saline, or other heavier parts; on which account, that portion we took up for our trial, might appear lighter than else it would have done; or unless (the experiment having been made in *London*, where great and sudden rains, and other accidents, will sometimes visibly vary the consistence of common water;) the liquor I then employed, without examining it, might be more ponderous at that time than at another. To the latter suspicion I was the more inclined; because, having afterwards weighed the same piece of sulphur, by help of the same balance, in distilled rain-water, I found the weight of the former liquor, to exceed that of the latter, by less, considerably, than a thirty fifth part; which seemed to make it probable, that if the water, we chanced to employ, had been free from all saline, and other heavy particles, the difference betwixt this observation and the foregoing, would not have been near so great as it was.

Again, a pound, *avordupois*, of the upper sea-water, was weigh'd out, and put into a head and body, to be distilled in a digestive furnace *ad siccitatem*; and the distillation being leisurely made, the bottom of the glass was almost cover'd with fair grains of salt, shot into cubical figures, and more white than we expected: in the rest of the coagulated matter we took no notice of any determinate shape. The salt being weighed, amounted to  $\frac{3}{4}$  *avordupois*, and 10 *gr.* At which rate the proportion of the salt to the water, will amount to near the thirtieth part; which was so much greater than the former ways of trial, made us expect, that, perhaps, it may be worth while to examine, whether such a slow abstraction as we made of the superfluous water, in close vessels, may not have afforded us more salt than otherwise we should have obtained.

But suspecting that somewhat else might have concurr'd, to yield so great a proportion of salt; I suffered that which had been weigh'd, to continue a while in the scale, and soon perceived, that the scale began manifestly to preponderate; and, consequently, that some of the unexpected weight of salt might be due to the moisture of the air, imbibed after the salt was taken out of the glass, and laid by to be weighed. Wherefore, causing it to be very well heated and dried in a crucible, we found it to weigh 210 *gr.* whence the proportion of salt contained in the water was about a thirty seventh part.

From whence this greater proportion of salt by distillation, than our other trials made us to expect, proceeded, seems not easie to determine; unless it be supposed, that the operation whereto the sea-water was exposed, made some great change in it; and that, though the salt we gained out of the sea-water, seemed to be dry before we weigh'd it; yet the saline corpuscles, upon concreting into cubes, so intercepted many small particles of water between them, that they could not be driven away by a moderate

NAT. HIST. warmth ; and, consequently, such grains of salt may have, upon this account, been less pure, and the more ponderous. And, indeed, I sometimes make a certain artificial salt, which, though being dissolv'd in water, it will shoot into crystals finely shaped, and so dry, as to be reducible into powder ; yet coagulates water enough with it, to weigh as heavy again as before. And I have been assured by a very learned eye-witness, that there is a sort of sea-salt, which they bring to some parts of *England*, from the coast of *Spain*, or *Portugal* ; that being here dissolved, and reduced, by purification and filtration, to a much whiter kind, will yield, by measure, above two bushels for one. But to determine with any certainty about the degrees of the sea's saltiness in general, a great number of observations, made in different climates, and in distant parts of the ocean, are necessary.

It might not be amiss, that observations were heedfully made, to shew, whether in the same sea, and about the same part of it, the water is always equally salt. For, though that be taken for granted, yet since we have no good, ancient observations, to ease the suspicion, 'tis not improbable, that, at least in many places, the saltiness of the sea may continually increase by the accession of those saline corpuscles that are imported by salt-springs ; and those which rivers and land-floods from time to time rob the earth of. And it seems not impossible, that a particular part of the sea may be sometimes extraordinarily, and perhaps suddenly, impregnated with an additional saltiness, from saline steams plentifully ascending into it, by means of subterranean fires. But it may prove the more difficult to discern this adventitious saltiness, unless the taste, as well as the balance, be employed about it ; because the salt that produces it, may be of such a nature, as to be much lighter in *specie* than common sea-salt.

Though the weight of sea-water, be as good a way as any yet employed, to determine what part of it most abounds in salt ; and though it be possible, that in our sea, and, perhaps, in almost all others, this way is not liable to any considerable uncertainty ; yet it may sometimes deceive us, especially in very hot regions ; because I have observed, that there are volatile salts, which, though by reason of their activity, they make smart impressions on the tongue, and give the water imbued with them a strong, saline taste, yet add very little to its specific gravity : as I have tried, by hydrostatically examining distilled liquors, impregnated with volatile and urinous salts ; some of which liquors I found very little heavier than common water, and, consequently, nothing near so much heavier as they would have been made, if they had been brought to so sharp a taste, by having nothing but common sea-salt dissolved in them. And therefore, if in any particular place, by any other way, or from the steams of the earth beneath, the sea should be largely impregnated with such kind of light salts, the sea-water may be much more salt to the taste,



taft, and yet be very little heavier. Thus a sealed bubble of glafs, NAT. HIST.  
made heavy by an included metal, weighed first in fpirit of fal-  
armoniac, that tafted much ftronger than fea-water, 3 iij. 51  $\frac{1}{4}$  gr. and  
afterwards, in fair water, but 3 iij. 45  $\frac{1}{4}$  gr. So that notwithstanding  
its great faltnefs, the fpirit was lighter than common water; though  
a large part of that comparative levity may, probably, be afcribed  
to the liquor wherein the faline particles fwam; which, by diffilla-  
tion, was grown more pure and light than common clean water.

But for a farther proof, we took a hard lump of fal-armoniac,  
and a lump of good white fea-falt, and found the proportion of the  
latter to a bulk of water equal to it, fomething above that of two  
and a quarter to one; and the proportion of the former, to an equal  
bulk of water, not above a centefm more than that of one and  $\frac{7}{10}$  to  
one; which falls fo fhort of the other proportion, that it may juftly feem  
frange; efpecially if it be confidered, that the factitious fal-armoniac  
which chymifts generally ufe, and we employ, confifts, in good part, of  
fea-falt, which abates much of the comparative levity it might have,  
if it were made up only of urinous and fuliginous falts, which are  
its other ingredients.

I fhall here add the greateft meafure of faltnefs whereto I have brought  
water, without the help of external heat. To which purpofe,  
I employed two different ways; the one was, by putting into a well-  
counterpoifed vial, two ounces of common water; and then adding to  
it, well dried and white common falt; and fhaking them together,  
till the liquor would, whilft cold, diffolve no more, this liquor,  
thus glutted with falt, weighed 1150 grains; from which two ounces  
being deducted, the overplus of weight, arifing from the diffolved  
falt, amounted to 190 grains; fo that a parcel of falt will, without  
heat, be diffolved in about five times its weight of common water.  
By which proportion we made fo ftrong a brine, that feveral pieces  
of amber, being purpofely let fall into it, emerged, and floated on  
it. The better way, tho' more tedious, that we made ufe of was,  
to let fea-falt run *per deliquium*, till it was diffolved by the aqueous  
vapours that swim in the air. In this liquor we weighed a piece of  
fulphur, which we alfo weighed in fea-water, wherein, finding it  
much heavier than in the former, it appeared that the fea-water  
was *in fpecie* much lighter than the other; but how much, I cannot  
remember.

I have alfo examined a hard, dry lump of fea-falt, and found its  
proportion in weight to common water of the fame bulk, to be  
almost as 2 to 1. But the fpecific weight of a hard and figured  
lump of *Sal Gem.* proved to that of water very nearly as 2  $\frac{1}{8}$  to 1.\*

G g 2

Con-

\* Dr. Halley thinks it advifable, that the | fhould be recorded, for the fake of poft-  
prefent degree of the faltnefs of the fea | rity,

NAT. HIST.

To examine  
the freshness of  
waters.

Considering that various metalline and mineral solutions, might be readily precipitated, not only by the spirit of salt, but by crude salt, whether dry or dissolved in water; 'twas easie to imagin, that, by means of this precipitating quality of common salt, one might discover whether any particles of it lay conceal'd in a proposed liquor.

To this end I employed several preparations; and tho' two or three of my other tryals had a tolerable success, yet that which, at length, I pitch'd upon as the most certain, is the following.

I took some common water distill'd in glass vessels, that it might leave its corporeal salt, if it had any, behind; and put into a thousand grains of it, one grain of dry common salt: into a convenient quantity, two or three spoonfuls, for example, of this impregnated liquor, I let fall a fit proportion, for instance, four or five drops, of a very strong and well filtred solution of well-refined silver, dissolved in clean *Aqua fortis*. I also made the tryal succeed with spirit of nitre; and herein, there immediately appeared a whitish cloud, that slowly descended to the bottom, and settled there in a white precipitate.

This experiment being several times repeated, was constant to success, having recommended it to me for between twenty and thirty years; tho' I make choice hereof without denying, that men of sagacity, especially if well vers'd in chymical operations, may, upon the same foundation, find some other cheaper way, tho' scarce any more nice and certain, of compassing the same end.

But to make the experiment rigorously, we usually took somewhat more than a thousand parts of water to one of salt. And having let fall a few drops of our metalline solution, into a liquor obtained by a particular way of edulcorating sea-water, there did not presently ensue any white cloud or precipitate, much less such an one as was afforded by the water, impregnated with less than a thousandth part of salt. And if, after some time, there happen'd to appear a little cloudiness in this factitious liquor, it was both slower produc'd, and much less than that which appear'd in the impregnated water.

Various solutions of mineral bodies may, also, be precipitated by dilution; that is, when the solution has time enough allow'd to diffuse itself, through a great quantity of water, the saline parts are thereby so attenuated and weaken'd, that they remain no longer able to sustain the mineral corpuscles, they kept afloat before; but make with them and the water, a confus'd subsiding mixture, usually of a whitish co-

urity, who, as he supposes, may, from the continual increase hereof, at length, discover the age of the world. The Doctor wishes the same thing had been done 2000 years ago, that we might have been at some certainty in this affair. For as the rivers, according to his hypothesis, gradually wash away the salt of the earth,

and deposit it in the main ocean, this must continually become more saline thereby; whence, two experiments made at large but equal distances of time, might, by the rule of proportion, tell us how long the sea has been in acquiring its present degree of saltiness. See *Philos. Transact.* N<sup>o</sup> 344. p. 296.

hour.

four. This appears when the butter of antimony, being put into common water, is thereby quickly and plentifully precipitated in the form of that white powder, the chymists call *Mercurius vita*. I have also produc'd a powder of that colour, by pouring into common water a strong solution of tin-glass made in *Aqua fortis*: and by the same way have precipitated the tincture of jalap, benjamin, labdanum, antimonial sulphur, and of other bodies, made in vinous spirits. Were it not for this power, that water has to weaken most solutions of bodies, I could have employ'd, instead of silver, either quick-silver dissolv'd in *Aqua fortis*, or lead, crude or calcin'd, in the same liquor, or rather in strong spirit of vinegar; since these, and some others, are found precipitable by salt-water into whitish powders. But tho' a very careful observer may make use of these metalline solutions, to guess at the quality of water, as to freshness and saltnefs; yet the precipitation made by dilution, is not difficult to be distinguish'd from that which is perform'd by a true and proper precipitant, both by the quickness of the effect, and the copiousness of the white substance produc'd; being on both these accounts very much inferior to it: as may evidently appear in the very different effects that our particular solution has upon the sea-water, peculiarly edulcorated, and upon well distill'd common water, compar'd with those it had upon water impregnated with a thousandth part of salt, and upon several common undistilled waters.

To proceed, the usefulness of this experiment is not to be estimated barely by the essay it helps us to make of dulcify'd waters, but much more by the estimate, that by its means may be made of natural fresh waters, whether of springs, rivers, lakes, wells, &c. For it being generally granted, that those waters, *ceteris paribus*, are the best, as well for wholesomeness, as other various oeconomic uses, &c. that are free from saltnefs; which is an adventitious, and in most cases, a hurtful quality in waters; by our way of examining these liquors, a heedful eye may in a trice discover, whether there be any latent saltnefs in them, and enable us, especially by the help of a little practice, to give a near guess, how much one water is fresher than another; as I have purposely try'd in different waters, that were ordinarily drunk by considerable persons. And if once you have attentively mark'd what change four or five drops, for instance, of our liquor, will make in two or three spoonfuls, or half ounces of water; 'twill not be difficult for a heedful observer, keeping the same proportion between the two liquors, to make a near estimate, whether any natural water propos'd have a greater, an equal, or a less degree of freshness or saltnefs, than that he has chose for a standard; and how much, in case there be a difference, the propos'd liquor is more or less free from saltnefs than the other.

And that such a difference in a liquor of such frequent internal use as water, may have considerable effects upon human bodies, in



NAT. HIST. respect of health, may be, probably, argued from the differing effects waters, more or less impregnated with salt, have upon several other bodies. Most pump-waters, for instance, will not boil pease and beef, &c. near so well as spring or rain-water, which is usually softer, and more free from the saltiness we speak of. 'Tis commonly known, that the same pump-water will not so well and uniformly, or without curdling, dissolve wash-balls and soap, as rain-water, and some running waters: nay, it has been confess'd by skilful artists, that some tools, as gravers, &c. made of the hardest steel, would receive a different temper if quench'd in pump-water, from that which the like extinction in spring or river water, would give them.

And as many medicinal waters, that are presum'd to owe their virtues to the participation either of metalline or mineral bodies, appear, upon tryal, to leave sometimes little, and sometimes nothing behind them, except a kind of common salt; our precipitant may greatly assist us to discover, whether a mineral water propos'd contain such a salt; and if it do, whether copiously or no. This I have tried upon more than one of our *English* mineral waters, and thereby found immediately, that one reputed of another nature, contained pretty store of saline matter; and that another is impregnated with a surprizing plenty of a saltish substance.

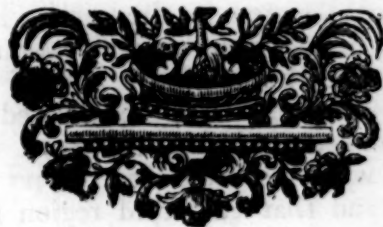
Tho', for certain reasons, I ascribe not to our method of examining waters, an ability to discover less than one part of salt in a thousand parts of water; yet if it were requisite, we might make more nice discoveries. For having, sometimes, by means of it, put one grain of salt into fifteen hundred of distilled water, we could manifestly make it appear, that even this liquor, tho' so lightly impregnated, was not destitute of salt, but contained more of it than some of the peculiarly edulcorated water: nay, I once found, that a grain of dry salt, being dispersed through two thousand, and at another time that being dissolved in three thousand times its weight of the same kind of liquor, so inconsiderable a portion of salt was plainly discoverable by our precipitant.

But it may be objected, that as the experiments hitherto mentioned have been made only upon waters impregnated with gross or corporeal sea-salt; they may, nevertheless, be imbued with the spirit of that salt, which, by reason of its activity, shall prove as unhealthful to the drinker, as the grosser salt it self. To this I might answer, that a very small proportion of spirit of salt, may, in many cases, make the water season'd with it, rather medicinal, than unwholesom; but to manifest the foundation of the objection to be false, I took above a thousand grains of distill'd water, and, instead of corporeal salt, put to it one single drop of moderately strong spirit of salt; and having shook it into the water, I let fall into a portion of this unequally compos'd mixture, some drops of our solution of silver, which presently began to precipitate in a whitish form; so that, for ought appeared to the eye, this tryal succeeded better than if the water had been impregnated with

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but a thousandth part of corporeal salt. The like experiment was made with water peculiarly edulcorated. And further, diffusing one drop of spirit of salt, into two thousand grains of distilled rain water; and letting fall some drops of our precipitant into it, the success well answer'd our expectation. But to urge the trial still further, I added as much of the same distill'd rain water, as, by conjecture, amounted to at least half as much more. So that one grain of spirit of salt had a manifest operation, tho' not quite so conspicuous as the former, upon above three thousand grains of saltless water; and possibly, if the vial could have contained more, and would not have been, when fill'd, too heavy for our tender balance, the discolouration of the mixture would have been discernable, tho' but one grain of spirit of salt had been put to four, or even five thousand grains of water. And that a drop of the saline spirit we made use of, did not equal, in weight, a grain of dry salt, appeared from hence; that having let fall into a counterpois'd glass, ten drops of that spirit, I found them to weigh but about  $8\frac{1}{2}$  grains.

The like trial I made, by substituting above a thousand grains of rain water, for the like quantity of distill'd water. And if five or six small drops of strong spirit of urine, were shaken into at least a thousand grains of distill'd or rain water, impregnated with but one of salt; our precipitant would make a discovery of some saltishness in the liquor. I have, also, found rain water, that I caus'd to be carefully sav'd, after the house-tops whereon it fell, had been well wash'd with former rain, to grow a little turbid, if any quantity of our precipitant were kept for a competent time in it. And being gently distill'd off, it left a residue, which, with a little of our solution, afforded a far more sudden and copious precipitate, than had been produced with the like quantity even of pump water it self. And tho' I have met with rain-water, that was more free from salt than any spring, or river-water, I remember to have examined; yet, having made trial of snow-water, which is thought be the lightest of all natural waters, I manifestly found it, by our way of examination, not to be destitute of saltiness.



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# T H E T E M P E R A T U R E O F T H E

## Subterranean and submarine Regions,

### As to Heat and Cold.

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#### S E C T. I.

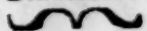
*Different regions, below the surface of the earth.*

A Chymist, who purposely travelled to visit *Hungary*, and other places famous for mines, assured me, that upon his descent into a mine of an exceeding great depth, he felt the air yet warm near the orifice of the groove; but afterwards descending towards the lower parts, he perceived it cold, till he came to such a depth as he scarce attained by descending for a quarter of an hour; and that the cold he felt during this time seemed considerable, especially when he was got pretty low down; that after he had pass'd this cold region, he began, by degrees, to come into a warmer; which increased in heat as he went deeper; so that in the lower veins he found the workmen digging, with only a slight garment upon them: and the subterranean heat, he said, was much greater than that of the free air on the top of the groove, tho' it were then summer.

This account of a cold region in the earth, has been since confirmed to me by a physician, from an observation made in another *Hungarian* mine, not of gold, but copper; and of a much less depth than the former. For in going down, he declared he felt a considerable degree of cold, and the like in his return upwards; that he began to feel the cold, when he could receive no more light by the mouth of the groove; and that this cold region lasted till he came near the bottom, which was estimated to be about 100 fathoms in a strait line from the top.

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This relation agrees very well with that of *Morinus*, who visited the deep *Hungarian* mines in the month of *July*, and takes notice, that when he came down to the burrows, as he calls them, he did not find any heat, as at the mouth of the groove, but the beginning of a very cold, and considerably thick region. He further informs us, that when they had descended about 80 fathoms beneath the surface of the earth, he began to feel a breath of an almost lukewarm air; which increased as he descended lower: and adds, that the overseer of the mine, who conducted him, affirmed, as did also the officers of other *Hungarian* mines, that in all their deep ones, after a thick tract of cold earth, there succeeds a lower region, which is always hot; and that after they arrived at such a depth, they felt no more cold, how deep soever they dug.

There seem, therefore, to be three kinds of subterranean regions, each of which deserves a particular consideration.

What we have to offer upon each may be thrown into the following propositions.

## PROP. I.

*The first region of the earth is very variable, both as to bounds and temperature.*

For, the manifest operation of the sun-beams, is, *ceteris paribus*, greater, and reaches farther in hot climates, than in cold ones; in the midst of summer, than in the depth of winter. Besides, in some places, the different solidity, or porosity of the earth, as also the nature of some salts, marcasites, and other bodies contained in it, may differently dispose the soil to cold or heat. And in the first region, the air is usually more temperate, than that above the surface of the earth; nor is this region considerably deep.

That in the upper region of the earth, it should be less cold than above the surface, seems reasonable; because the subterranean cavities are shelter'd by the thickness of the sides, from the direct action of the sun-beams, the wind, &c. and is also kept from an immediate, or full contact with the external air, when that is vehemently either heated or cool'd.

That the heat of the sun much less powerfully affects such places, as are shelter'd from its action by solid bodies, appears by the repositories of ice or snow, wherein 'tis kept during all the heat of summer; and that, oftentimes in cavities which are at no considerable depth beneath the superficies of the earth. Nay, having had occasion to keep ice for many weeks, after the frosty weather was gone, I did it, without either digging to a considerable depth in the ground, or building any substantial structure over the cavity.

And a gentleman told me, that in the southern part of *France*, where the heat seem'd to exceed that of several parts of *Italy*, some curious persons, who resolv'd to have ice in summer at any rate, tho' they could not dig four feet into the ground without meeting

**NAT. HIST.** with water, they were yet able to make reservoirs, by covering a brick building, that stood over their pits, with clay and sand, to a very considerable thickness; and taking care, that the only place which should admit access to the outward air, was a small northern door, fitted exactly close, and fenced with a little porch, furnished with another door. And by this means, he affirms, these gentlemen preserv'd the same included ice, sometimes for two or three years together.

And even where the intercourse is not debarr'd betwixt the subterranean and the superior air, the operation of the sun-beams may be very much less in a shallow cavity beneath the surface of the ground, than above it. For trials have informed me, that liquors, differing in little else than in consistence, will not so easily pervade each other, as a man would imagine; unless some external motion promote their intimate mixture.

Descending, late in the morning, into a pit, where they were digging out iron-ore, tho' this cavity had no very narrow orifice, and was dug directly downwards, and exceeded not ten or twelve feet in depth; yet I found the heat no way troublesome, while I stayed there, tho' the pit were in an open field, unshaded by trees; and tho' the air abroad, were much heated at that time of the year, which was in the dog-days.

And as the subterranean air, even in the first region, is usually much less heated, than that above the earth; so the lower air is, *ceteris paribus*, much less refrigerated, by the grand efficient of cold, than the upper. For the subterranean air, being, tho' comparatively cool, yet indeed moderately warm in summer, ought not be affected with the winter's cold, so much as that contiguous to the surface of the earth; from whose immediate contact it is defended by a thick arch: and that the cold reigns most in the free air, and the superficial parts of the terrestrial globe, appears, because water begins to freeze at the top, not at the bottom. And, we see, that in cellars arched, and carefully kept close from the communication of the outward air, beer, and other liquors, may be kept from freezing in frosty and snowy weather; as I have observed in a shallow cellar, but well arch'd, during a severe winter; which froze stronger liquors than beer, in another adjoining cellar, that differ'd not much from it in depth, but had not so thick and solid a roof. And even in *Russia* it self, where the cold is extreme, it reaches not near so deep as one would expect.

#### PROP. II.

*The second region of the earth seems to be generally cold, in comparison of the other two.*

It seems reasonable, since the earth is naturally a body consisting of gross and heavy parts, usually much less agitated than those of our organs of feeling, that it should, as to sense, be cold; and therefore that quality may be justly ascribed to it, in a region, where, by  
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its situation, it is kept from being considerably affected, either by the heat of the upper air, or by that of the deep parts of the earth; which are the two agents that seem, of all others, the most likely to put its parts into an unusual motion; and thereby change its natural temper. And that the proposition agrees with experience, may be gather'd from the foregoing relations.

But then this coldness ascribed to the second region of the earth, is to be understood comparatively to the other two. For otherwise, even this earth is not the *summum frigidum*; for I could never hear of any ice met with there, at any time of the year. Nay, those who have descended far enough into this region, have not found the cold any where very great, or in some places not at all considerable. And indeed, at the mouth of deep grooves in mines, the steams that ascend, often feel warm; tho' the outward air, where the observation is made, be affected with the heat of summer; which seems to argue, that the middle region of the earth, thro' which these steams must ascend, is not very intensely cold.

PROP. III.

*In several places, which, by reason of their distance from the surface of the earth, might be referr'd to the middle region of it, the temperature of the air is very different, at the same seasons of different years.*

I have learn'd from several persons, who have here, in several parts of *England*, had occasion to descend into deep pits, or grooves, of different minerals; that they felt in summer-time, a remission of the heat of the external air, as soon as ever they began to descend; and that this warmth did not so far decrease, as to end in any notable coldness, before they came into a deeper part of the earth, where that quality never troubled them. And I had it from a mathematician, who was often employed about lead-mines, that at such depths as, according to *Morinus*, the second region of the earth reaches, he observed it to be sensibly warm at all seasons of the year.

Nor is it improbable, that the middle region of the earth should be of different temperatures, in different parts, upon account of the variations, only, which the climate may produce, by being very much hotter, or very much colder, in one place, than in another; but from the peculiar constitution of the soil.

And this temper of the soil it self may be diversified, not only by its greater or less compactness, but from the nature of the springs, or subterraneous liquors, that may abound in it, or strain thro' it into the groove; and that especially by the minerals, as salts and marcasites, that grow near the sides of the well, or are brought thither by the waters.

Nature does not regulate her self under ground by our imaginary divisions; but produces marcasites, salts, and other minerals, most frequently, perhaps, in what we call the lower region of the earth; yet sometimes too in our upper, and often in our middle region. Let us



**NAT. HIST.** then suppose, that in some places of the latter, there is a mine of that earth, naturally abounding with embryonated nitre, or other salt, that is apt to send out refrigerating effluvia, or by its contact to cool the air. Let us also suppose, that by the sides of another well, of the same depth, there are numerous unripe minerals, in the process of generation, or rather, a great quantity of marcasitical earth, yet of so open and loose a texture, that not only water, but air also, would, in a few hours, evidently work upon it. And since, whilst marcasites slowly dissolve, it has been observed, that many of them will conceive a considerable degree of heat; 'tis very probable, that the temperature of the earth, in the place abounding with these marcasitical minerals, will be very warm, in comparison of the temperature of the other place, where the soil plentifully produces nitrous and other refrigerating bodies; tho' both the places be suppos'd at the same distance from the surface of the earth, and consequently in the same subterranean region.

Upon the like grounds it may also be suspected, that in the same place the temperature will not be always the same; even upon account of the soil. For some saline earths, that partake of the nature of marcasites, admit a kind of gradual maturation, and perhaps other changes which seem spontaneous; and such changes may happen the more remarkably in those parts of such bodies as are exposed to the air, which are the parts placed at the sides of the deep wells we are talking of.

Hence a mineral, to which either heat or cold is to be referr'd, may be more plentiful, ripe, and operative, at one time than at another; or, at length, all the earth capable of being assimilated by the mineral rudiments harbour'd in it, may be consumed; or the mineral it self arrive at a perfection of maturity, which will render its texture close, and unfit to be penetrated, and wrought upon, as before, by the water, or other liquor, which occasion'd its heat.

#### P R O P. IV.

*The third region of the earth has been observed to be constantly and sensibly, but not uniformly warm; being in some places considerably hot.*

Almost all the deep grooves that mineralists have given us accounts of, and wherein men have wrought long enough, to take sufficient notice of the temperature of the air, have been made in soils furnished with metalline ores, or other minerals, without which, men would not be at the charge of sinking so very deep into, and maintaining workmen in them; so that experience has yet but slenderly, or, at least, not sufficiently informed us of the temperature of those parts of the third region of the earth, that are not furnish'd with ponderous minerals; and consequently it has not informed us of the temperature of the lower region in general.

Having purposely inquired of several persons, who had visited and frequented the third region of the earth, in different countries and soils,  
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and at different depths and seasons of the year, I did not perceive that any of them had ever found it sensibly cold. And suspecting, that, in some cases, the narrowness of the cavities, wherein the diggers were reduced to work, might make the warmth, they felt, proceed, in great part, from the steams of their own bodies, and, perhaps, of the minerals, and from the difficulty of cooling the blood in the air clogg'd with effluvia; I inquired, whether the heat of the subterranean air, in such places, might not be referr'd to the like causes. But I was answered in the negative, particularly by an inquisitive person, who had been in the deepest and hottest mines that have been visited by any acquaintance of mine.

There are still, I think, two principal causes to which we may, probably, refer the temperature of those places where the air is but moderately warm.

And first, the coldness of winter may not be felt in the lower region of the earth; because the air there is too remote from that above the earth, to be much affected with those adventitious causes of cold, which make that quality intense in the open air. But possibly the positive cause of the actual warmth there, may proceed from those deeper parts of the subterranean region, which lie beneath the places where men have yet had occasion to dig. For it seems probable, that, in these yet unpenetrated bowels of the earth, there are great store-houses, either of actual fires, or places considerably hot, or in some regions, of both; from which magazines of subterranean heat, that quality is communicated, especially by channels, clefts, &c. to the less deep parts of the earth, either by a propagation of it thro' the solution of the interposed part of the soil, or by a more easy diffusion of the fire or its effects thro' the above-mentioned conveyances; or else by sending upwards hot mineral exhalations and steams, which, by reason of the comparatively heavy materials, whereof they consist, and of their being less dispers'd nearer the parts from whence they proceed, are usually more plentiful in the deeper parts of the earth, and somewhat affect them with the quality that they brought from the places where they were form'd.

That manifest steams are often found in grooves, especially in deep ones, is evident by the damps which infect most of them; and this in distant regions, as several provinces of *Germany*, *Bohemia*, *Hungary*, &c. as also in several parts of *England*. By which it appears, that several of these exhalations ascending from the entrails of the earth, are sulphureous, bituminous, and, in some grooves, apt to take fire. However, the easie inflammability of bodies is not always a sure proof of the actual sensible warmth of the minute parts they consist of. For tho' salt-peter be very inflammable, yet being by solution, in fair water, reduced to invisible corpuscles, it highly refrigerates that liquor. Nor have I observed its fumes, when far from the fire, to have any heat sensible to the touch. And the like may be said of the exhalations of highly rectified spirit of wine, which yet, we know,

NAT.HIST.

**NAT. HIST.** is it self totally inflammable. Nay, large exhalations may ascend from the lower parts of the earth, and yet be rather cold than hot. For I have made a mixture, that plentifully emitted steams, even whilst its component ingredients, briskly acting upon one another, were considerably cold.

But having purposely inquired of an observing man, who frequented deep mines, wherein he had a considerable share; he assured me, he plainly observ'd the fumes that came out of the mouths of them to be actually and sensibly warm, and this in a warm season of the year. And *Morinus*, speaking of the deep *Hungarian* mines, tells us, the large exhalation, that ascended from the bottom, was hot. And that at the mouth of a well, the ascending fumes were sensibly hot, even in summer.

That also in many places of the earth, where no grooves are dug, and no visible exhalations taken notice of, effluvia may yet pervade the soil, and exercise some operations of warmth, appears, probably, from hence; that *Agricola* reckons it, among the signs of a latent mineral vein, that the hoar-frost does not lie upon that tract of the surface of the earth, under which a vein runs. The like directions I have known given by the skilful in *England*, for the discovery of places that contain coal-mines. And a near relation of mine shew'd me a great tract of his land, which, he affirmed, would not suffer snow to lie upon it for above a day or two, in the midst of winter.

A very ingenious gentleman, also, who lives among mines, and is concern'd in some of them, assured me, that in some places which he knew to have mineral veins beneath them, he observ'd, neither snow nor ice would continue scarce at all upon the surface of the ground, even in an extraordinary cold winter. And some learned men tell us, that near the gold-mines in *Hungary*, the leaves of the trees are often found of a golden colour, proceeding from the metalline exhalations of the mines; which, one would think, must, by reason of their weight, require a considerable heat to raise them into the open air.

These latent fires and heats in the bowels of the earth will, it may be said, account for the warmth only of those places that are within reach of the action of such efficient, which are, probably, wanting in many parts of the earth.

But the troublesome degree of heat, to be found in some places of the third region, seems not always to be derivable from the two causes already assigned; which must, to produce so considerable an effect, be assisted by a third, more powerful than themselves; and this seems to be the incalcescence there is, in many mines and other places, produced by the mutual action of the component parts of immature and more loosely context'd minerals, promoted by water; and especially such as are of a marcasitical nature.

That such an incalcescence may be thus produced in the bowels of the earth, appears by example of the like, producible in mineral bodies above ground



ground. And that marcasites, which, for the most part, abound in vitriol, are bodies very fit to afford this subterranean heat, may be confirmed by the sulphureous and saline parts they contain; and by being many of them easily wrought on, both by simple water, and even by the moist air. And a gentleman, who went to visit one of the deeper *Hungarian* mines, assured me, that in the lower parts of the mine, he gathered vitriol, which appeared above-ground to be of a golden nature; and that in a cave on one side of the groove, in the deep gold-mine near *Cremnitz*, the corrosive smell is so strong and noxious, that men dare not dig out the rich metal it abounds with; being deterr'd by the ill fate of several, who ventured to work in it. He further told me, that tho' he pass'd by it in great haste, yet he was offended by the noisom exhalations: and lastly, that in gathering this vitriol deep under ground, he found some of it soft; but that when he had brought it into the open air, it harden'd, and appeared to have several golden streaks in it.

I must not here omit, that the diggers in mines having found, by sad experience, that in deep grooves, the air, unless renewed, does, in a short time, become unfit for respiration; have been obliged to sink, at some convenient distance from the groove, where the miners work, another pit, that usually tends directly downwards; to which our *English* miners, in several parts of this kingdom, give different names; but 'tis call'd in the lead-mines of *Derbyshire*, an air-shaft; where it is made 40, 50, and sometimes 80, or 100 paces off, and as deep as the groove. From this air-shaft to the groove, wherein the men work, there passes a channel, to convey the air from the former to the latter; which is what *Agricola* sometimes calls *Cuniculus*, and which, in the above-mentioned lead-mines, is called a drift; because the air usually, in the form of wind, drives thro' it, and thereby enables the workmen to breathe freely at the very bottom of the pit. And a very observing man, who much frequented these mines, told me, that at the depth of about 200 yards, he found, by the means of the air-shaft, that the air was very commodious for respiration; and also temperate as to heat and cold. But *Agricola* gives an odd account of the course of the air in the shaft and the pit; asserting it to come "from the upper to the lower, in the spring and summer seasons; and the contrary way in autumn, and the winter: he adds, that "the air, before its usual course comes to be durably settled, is, for the space of a fortnight, liable to frequent changes; "sometimes flying into the upper or higher groove, or drift; and "sometimes into the lower, and passing out at the other."

If this observation constantly holds, it may hint some odd inquiries about considerable periodical changes in the subterranean part of the earth, or in the air, or both; which have not yet been regarded. Tho' I must own; that a very observing person, who had the chief hand in contriving the subterranean structures in some deep lead-mines, assured

NAT. HIST. assured me, that both winter and summer, the current of air went constantly the same way; the air entering in at the mouth of the air-shaft, and coming out at the perpendicular groove. And *Morinus* tells us, that in the deep *Hungarian* mines he visited, the outward air pass'd first thro' the burrows, and so thro' by-ways, that tended not directly downwards, but reached, at length, to the bottom of the perpendicular groove; whence, together with the steams, proceeding from the mine, it ascended strait upwards; without taking notice of *Agricola's* observation, about the different course of the subterranean air, at different seasons of the year.

But these accounts are accommodated only to the few informations I have hitherto procured; and are therefore only propos'd to be rectified, or confirmed, by future observations.

In the mean time, we may gather from the whole, that tho' in some mines three subterranean regions, with their distinguishing properties, are not inconveniently assignable; yet, generally speaking, in the whole body of the terrestrial globe, as far as we know it, both the bounds, and the temperature of the regions of the earth, as well as those of the air, are very various and uncertain.

And much less have we any certain knowledge of the temperature of the more central parts of the earth; in which, whether there be not a continued solidity, or great tracts of fluid matter; and whether different regions are to be distinguish'd, and what is their number, order, thickness, &c. we are wholly ignorant.

What we have discuss'd, belongs only to the temper of those subterranean parts, to which men have been enabled to reach by digging. 'Tis true indeed, that some mines, especially in *Germany* and *Hungary*, are of a vast depth; yet the deepest of all the mines, that I have as yet read, or heard of, from any credible relator, is that which *Agricola* mentions to be at *Cotteberg*. But what proportion does this it self, tho' it reach to above 3000 feet, bear to the whole depth of the terrestrial globe, whose semi-diameter is more than 4000 miles?

## S E C T. II.

Two different  
regions below  
the surface of  
the sea.

THO' the air and the earth have, as to temperature, been distinguished into three regions; yet the informations I have hitherto met with, assign no more than two to the sea: the former whereof may be supposed to reach from the superficies of it, as far downwards as the manifest operation of the sun-beams, or other causes of warmth, penetrate; from which, to the bottom of the sea, the other region may be allowed to extend.

But

But according to this division, the limits of the upper region will not be always constant; for in the torrid zone, and other hot climates, it must, *ceteris paribus*, be greater than in the frigid, and the temperate zones; in summer than in winter; and in hot weather than in cold; supposing in these cases the heat to come from the sun and the air; and not, as sometimes it may, from subterranean exhalations.

The same causes will, likewise, alter the temperature of this region. This temperature may, also, be chang'd in some few places by, at least, two other causes; the one is, the different constitution of the soil that composes the shore; which may affect the neighbouring water, if it extraordinarily abound with nitre, marcasites, or other substances, able to increase or lessen the coldness of the water.

Another cause may be, the figure and situation of the less deep parts of the shore, which may, in some sort, reverberate the heat that proceeds from the sun; and upon such an account, either add to the warmth, or allay the coldness that would otherwise be found in the neighbouring water. There may, indeed, be other exceptions to the rule; tho', perhaps, referable to the two cases already mentioned. Thus *M. de Monts*, in his voyage to *New-France*, tells us, that "about the 18th day of June, he found the sea-water, during three days space, very warm; and that their wine, by the same heat, was warm'd in the bottom of the ship; tho' the air was no hotter than before." And, that "on the 21st of the same month, they were, for two or three days, so encompassed with mists and cold, that they thought themselves in the month of January; the water of the sea being extremely cold, which continued till they came upon the bank."

The temperature of the lower region of the sea is generally cold. For water, being in its most ordinary state, a liquor, whose parts are more slowly agitated, than those of mens organs of feeling, must be, upon that account, cold as to sense; and consequently, those parts of the sea, which are too remote to be sensibly agitated by the sun-beams, or wrought upon by the warmth, which the air, and upper parts of the earth, may from other causes receive, should feel cold to those who descend into it; except in a few places, where the cold may be either expell'd, or allay'd by hot springs, or terrestrial exhalations, flowing, or ascending from the subjacent earth, or the lower parts of the shore, into the incumbent, or adjacent parts of the water.

I shall now subjoin some relations I procured, from persons who had occasion to go down into the lower region of the sea; or otherwise to take notice of its temperature, in very different regions of the world, and at very unequal depths.

*Relations about the temperature of the sea.*

A profess'd diver, several times complain'd to me, of the coldness of the deep water in the north sea, which kept him from being able to stay in it so long, as he otherwise might. He added, that he constantly found the cold increase, the deeper he descended.



NAT. HIST.

An acquaintance of mine, who made a long stay in *North-America*, and who took pleasure in swimming under water, told me, that tho' he scarce remember'd himself to have dived above two fathoms beneath the surface of the sea; yet even at that small depth, he observed the water to increase in coldness, proportionably to his descent: which argues, that tho' the sun-beams often penetrate plentifully enough to carry light to a great depth under water; yet they do not always bring with them a sensible heat; and that, at least in some places, the upper region of the sea reaches but a little way.

A person of quality, who had been present at the coral-fishing upon the shore of *Africa*, and who was himself a diver, inform'd me, that tho' he had seldom descended above three or four fathoms, yet he found it so much colder than near the top of the water, that he could not well endure it; and that being let down to the bottom of the sea in a great diving bell, tho' the water cou'd not come immediately to touch him, he found, when the bell came first to the ground, the air in it was very cold; tho', after he had stay'd a while there, his breath, and the steams of his body, made him very hot.

A famous commander, who had been upon the *African* coast, informed me, that, in the day-time, he there preserved his wine in a tolerable temper, by keeping it at the bottom of the ship in sand; but that in the mornings, he had it greatly cool'd, by sinking his bottles over-night into the sea, and letting them hang till morning, at twenty or thirty fathoms deep under water.

An intelligent gentleman, who sailed far up the river *Gambra* in a small frigate, assured me, that in the sea, even of those hot climates, wine may be preserved cool, by letting down bottles in the evening, exactly stopp'd, to the depth of twelve or fourteen fathoms; whence being the next morning drawn up, they find it very fresh, if presently drank; otherwise the heat of the air on the upper part of the water would quickly warm it.

I remember too, that a man of letters, who sailed to the *East-Indies*, told me, 'twas the practice of his captain, and other persons of note, whilst they pass the torrid zone, to keep their drink, whether wine, or water, cool, by letting it down in bottles to the depth of eighty, ninety, or sometimes an hundred fathoms; and suffering it to stay there for a competent time; after which, they found it to be exceeding cool and refreshing.

Lastly, to satisfy my self as far as I could, to how great a depth the coldness of the sea reached; meeting with a curious traveller, who had been in several parts of the *East* and *West-Indies*, I enquired of him, whether he had taken notice of any extraordinary deep soundings in the vaster seas; to which he answer'd, that sailing to the *East-Indies*, over a place on the other side of the line, that was suspected to be very deep; they let down 400 fathom of line; and that the lead, which weigh'd about 30 or 35 pounds, thereby received

so intense a degree of coldness, that he thought a mass of ice could not have more vehemently affected his hands; and this observation was made in about the 35<sup>th</sup> degree of south latitude. NAT.HIST.

These are the chief relations I have hitherto been able to procure, about the temperature of the sea; which, if they happen to be confirmed by others, we may thence conceive, that, with regard to temperature, those two fluids, air and water, have this in common, that where their surfaces are contiguous, and in the neighbouring parts, they happen to be sometimes cold, and sometimes hot, as the particles they consist of chance to be more or less agitated, by the variously reflected rays of the sun, or other causes of heat; but that the parts of the air, called the second region, and the lower region of the sea, being more remote from the operation of those causes, retain their natural or more undisturbed temperature; which, as to us men, is a considerable degree of coldness: so that the regions of the water and the air seem to answer one another, but in an inverted order.

We may farther conclude from the preceding accounts, that the sea-water is not the *summum frigidum*. And, indeed, tho' I have been able, several times, to produce ice in salt-water; yet I find not by any observation, that there has been ice met with, and generated at the bottom of the sea; under which the earth has been found unfrozen by our divers, and appears to be soft at depths, exceedingly surpassing the greatest they have reach'd to; as is evident by the mud, gravel, &c. fetch'd from the bottom of the sea by sounding-plummets, let down to above an hundred fathoms. And a sober commander of a ship, lately arrived from the remoter parts of the great ocean, informed me, that at about 35° south latitude, the tallow of his sounding-lead brought up grey sand from 220 fathoms deep. But we cannot conclude, because no ice is found at the bottom of the sea, that the cold there cannot be very intense; for as the sea is, at least equally salt at the bottom, as at the top, so I have more than once try'd, that salt-water will, without freezing, admit a much greater degree of cold, than is necessary to turn fresh water into ice.

One of the chief things I have been solicitous to inquire after, as to the bottom of the sea, was the inequality I supposed to be in the soil; of which I received the following accounts. Relations about the bottom of the sea.

A person, who had been at the famous pearl-fishing, in the little island of *Manar*, near *Ceylon*, in the *East-Indies*; and had by his stay there, great opportunity to see divers at their work, and converse with them; assured me, he there learn'd, that the floor of the sea was in many places exceedingly unequal; being here flat, and there craggy; rocks rising to a considerable height in some parts; and valleys sinking as deep in others; in which they found it excessive cold. The inequality of its floor.

An ancient commander, who had for many years frequented *Africa*, and the *Indies*, told me, as others had done before, that when they

failed in the ocean, very far from land, they seldom sounded; but as far as they had, he usually found the depth of the sea to increase or decrease gradually, without very great irregularities, excepting in some places; instancing particularly, in the hollow that makes the bottom of the sea within sight of the cape of *Good-Hope*; where, tho' for the most part, he found the water to grow deeper as he sailed farther from the shore; yet, in one place, he and others had met with a bank at a considerable distance from the surface of the water; so that tho' when they were, as they imagined, near the edge of this bank, they found but a moderate number of fathoms; yet when sailing a very little way farther, they had gone beyond it, the sea prov'd of an immense depth. In short, I gather'd from his answers, that in the greater seas he had found, for the most part, the ground, at the bottom, to fall away by degrees; but nearer the shore, he observed, in several places, that it was very unequal, and had, as it were, hills and precipices.

A man of learning, who had sail'd both to the east and west *Indies*, and had made some of his voyages in ships of such great burthen, as obliged the mariners to be frequent and careful in sounding, informed me, that, sometimes, at considerable distances from shore, he had observ'd the sea to be twenty, thirty, or, perhaps, forty fathoms deeper when they cast the lead from one side of the ship, than it had been just before, when they sounded from the other.

In the notes of a very skilful pilot, lately arrived from the east *Indies*, I found the following observations: "Feb. 12. Seeing the ground under us, we heav'd the lead, and had but nineteen fathoms, rocky ground, then hal'd by N. N. E. the wind at N. W. and found our water to shoal from nineteen to ten and eight fathom, hard coral ground; then it suddenly deepen'd again from eight to twenty and twenty two fathoms, sandy ground; and then we suddenly saw rocks under us, where we had but seven fathom, and the next cast fourteen fathom again. And so having run N. N. E. from six in the morning till twelve at noon, about nineteen miles, we deepen'd our water from sixteen to twenty five, and the next cast no ground, with thirty five fathom of line."

Having met with an ancient navigator, who passes as the most experienc'd pilot in our nation for an *East-India* voyage, I ask'd him about his own observations concerning these unequal soundings; and he told me, that he had not only met with them elsewhere; but that not far from the mouth of our channel, he had sometimes found the bottom of the sea so abrupt, that in sailing twice the length of his ship, the water wou'd deepen from thirty to a hundred fathoms, if not much more.

And a noble person, who has, several times, had the command of the *English* fleet, informed me, that he had observ'd the bottom of the sea to be exceeding unequal in neighbouring places; and that sailing once, even in our channel, he perceiv'd the water to make a rippling noise, like that of the *Thames* under *London bridge*, so that he was afraid they



they were falling upon some shoal; the water being twelve or fourteen fathoms deep; and going a little further, he cast out the plummet again, and found it about thirty fathoms. He added, that he had made many such observations, but took notice of rippling water only when the tide was ebbing; yet in a deep sea, meeting with the like in the upper part of the water, and thinking it improbable there should be any shoal there, he order'd the depth to be sounded, and found it to exceed thirty fathoms; and after he had pass'd on a little further, the sea was so deep, that he could not fathom it with his ordinary line.

Another thing observable, at the bottom of the sea, is, the great pressure of the water there against other bodies. But for a manifest proof of this, we caus'd a cylindrical glass, that was open only at one end, to be so depressed in a glass-vessel full of water, with a convenient weight of lead, that none of the air cou'd get out; whilst we easily discern'd thro' the liquor and vessels, which were all transparent, that as the inverted cylinder descended deeper, the external water compress'd the imprison'd air, and ascended higher in the cavity of the cylinder; against whose sides we had before-hand plac'd a row of marks, whereby to take notice of the gradual ascent and descent of the internal water.

*The pressure at the bottom of the sea.*

Having inquired of two several persons, one whereof had, with a diving-engine, been at the bottom of the sea in a cold northern region; the other having done the like, in an engine much of the same sort, upon the coast of *Africa*; I found their relations to agree in this, that the deeper they descended into the sea, the more the air, they carried down with them, was compressed; and the higher the water ascended above the lip or brim of the engine into the cavity of it.

And an engineer of my acquaintance, who had been often at sea, and lov'd to try conclusions, assured me, that having, several times, sailed near the streights mouth, over a place where the sea was observed to be of a notable depth, he found, that if he let down with a weight, into the sea, such a vial as the sea-men use to carry their brandy in, containing a pint or a quart, it wou'd, when it came to be sunk forty fathoms under water, if not sooner, be so oppress'd, as to be crush'd to pieces. He also averr'd, that having exactly clos'd a metalline æolipile, and with a competent weight sunk it sixty fathoms into the sea; when he pull'd it up again, he found, that the great pressure of the water had, in several places, crush'd it inwards.

A third thing observed, at the bottom of the sea, is, the tranquillity of the water, if it be considerably distant from the surface. For tho' the winds have power to produce vast waves in that upper part of the sea, which is expos'd to their violence; yet the vehement agitation diminishes, by degrees, as the parts of the sea lie more remote from the superficies; so that towards the bottom, if that lie

*The tranquillity of the water at great depths.*

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NAT. HIST. considerably deep, and far from shore, the water is scarce sensibly disturbed.

This calmness of the sea will appear strange to many, who, admiring at the force of stormy winds, and the vastness of the waves they raise, do not, at the same time, consider the almost incomparably greater quantity and weight of water that must be mov'd, to make any great commotion at the bottom of the sea; upon which so great a mass of salt-water is constantly incumbent.

But a diver, who, by the help of an engine, could continue for some hours under water, inform'd me, that the wind being strong, so that the waves were manifestly six or seven feet high above the surface of the water, he found no sign of it fifteen fathoms deep; but that if the blasts continu'd long, they then mov'd the mud at the bottom, and made the water thick and dark; and that staying once at the bottom of a deep sea very long, he was amaz'd, at his return to the upper parts of the water, to find a storm there, which he dreamt not of; having left the surface calm when he descended.

A great traveller, who had assisted at a rich pearl-fishing in *East-India*, told me, that he had seen the divers descend when the sea was so very rough, that scarce any vessel would venture out of port; yet those returning divers assured him, that, at the bottom, they had found no disturbance of the water; and, this tho' the situation render'd it exceeding likely to be a troubled sea.

And a very eminent sailor assured me, that having, sometimes, been in great ships that drew much water, he had dived to the keel of them, when under sail, and observed the agitations of the water to be exceedingly diminished, even at that small distance from the upper part of the waves; he added, that in *America* he learn'd to dive of the *Indians*, who taught him, by their example, to creep along by the rocks and great stones, that lay near the shore, at the bottom of the water, who thus shelter themselves from the strokes and other ill effects of the billows, which, near the shore, when the sea is shallow, often hurt and endanger swimmers and unskilful divers. But when they are, by this means, got farther from shore, and into deeper water, they will securely leave the shelter they had, till then, made use of, and swim within a few yards of the surface of the sea; fearing there no danger from the tossings and commotions of the upper part of the water.

And farther, a great commander at sea, who has both an extraordinary curiosity, and an unusual care in making observations, inform'd me, that he had lately been at a place when the sea was often tempestuous; and that they found, by a sure mark, the storm did not reach, with any efficacy, four fathoms beneath the surface of the water.

I have solicitously inquired, whether the tides reach to or near the bottom of the deeper seas; but found it exceeding difficult to obtain any satisfaction about a problem, that most navigators, I have convers'd with, seem not to have dream'd of.

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Indeed,

Indeed, I have heard, of currents driving the sounding line, at a great depth, with a brisk motion, contrary to that of the ship; and a skilful observer, who commanded many of our *English* men of war, own'd to me, that he had, near the *Sound*, observed the upper and lower parts of the water, to move, with a considerable swiftness, different ways.

But one of the most ancient and experienced pilots of our nation, assured me, that sailing beyond the cape of *Good-Hope*, into the south seas, he made trials of the motion of the upper parts of the water above the lower; where, sometimes, casting out a large heavy plummet, he let it down to several depths short of 50 fathoms, without any sensible operation upon the motion of the boat he stood in; but when he sunk his plummet lower, to about 100 fathoms; he then found, that tho' it reached not to the bottom of the water, yet his boat turned towards the tide or current, as if it lay at anchor; the water running by the side of the boat at the rate of three miles an hour.

And one, who spent some time at a famous *Eastern* pearl-fishing, told me, the divers affirmed to him, that sometimes at the bottom of the deep waters, there seem'd to be a stagnation of the sea; so that they would, to a particular height, rise directly upwards; but that at other heights, they were carried away by the shallower waters, so as to be found, when they emerged a great way off, from the point of the surface, perpendicular to that part whence they began to ascend.

Lastly, a learned merchant sent me the following account, of an extraordinary in-draught of the sea, on the coast of a great island of the southern ocean. "At *Campar* and *Rakan*, on the east coast of *Sumatra*, is in the river's mouth, to a certain distance, at each new and full moon, a violent in-draught of the sea, called *Bunna*, which approaches with an hideous noise, and mountain high; so that what-ever opposes it perisheth. Its approach is in three parts, the first high, but not so terrible; the second high, black, and horrid; the third low, and of gentle motion. Before its approach, it gives so fair warning, that the sailors may eat, and bathe themselves, before they weigh anchor; but when they weigh, they must row hard against it; and when its fury is past, follow with it, till they return to their anchor-place. The true reason hereof the inhabitants cannot discover. My opinion is, (adds my relator) that the mouths of the rivers there, being choaked up with their sand-banks, and so render'd very shallow; when the great spring-tides come rolling over those shoals, at the new and full moon, out of the *Malacca* streights, the first influx is irresistible by such small vessels as use that port; whence they are forced to weigh, and bear up against it, for fear of being stranded or split."

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NAT.HIST. The last observable I shall mention is, the growth of plants at the bottom of the sea.

Plants growing at the bottom of the sea.

An eminent and inquisitive person, who spent some time on the coast of *Africa*, where he was present at a coral-fishing, told me, he had found coral soft and flexible, but not truly red, when first brought up into the air; the bark being worse coloured, than the substance it cover'd; but that when the bark was taken off, and the other part expos'd to the air, the redness disclos'd it self. When I demanded, whether he had observed any inky sap ascend, to nourish the stony plant; and whether he had seen any thing like berries upon it; he ingenuously confess'd to me, he had not been so curious as to make inquiry into those particulars; but that having broken some of the large pieces, he took notice, that the more internal substance was much paler than the other, and very whitish; and that at the extreme parts of some branches, or sprigs, he observed little blackish knobs; which he did not then know what to make of. But as to the depth of the sea in that place, he said, 'twas 9 or 10 fathoms.

And a gentleman, who sail'd much in the *East*, assured me, they often meet in those seas, with a certain sort of coral, not white, which bears a small fruit like a round berry, of a pleasant colour, and esteem'd a rarity.

Asking a profess'd diver, whether he had not found trees, or fruit, in the depth of the sea; he told me, that in a great ship whereinto he descended, to recover thence some ship-wreck'd goods, he was surpriz'd to find, in several places, a certain sort of unknown fruit, of a slimy and soft consistence, about the bigness of apples, but not so round in shape; which, when he brought up into the air, soon began to shrink like old rotten apples; but were much harder, and more shrivel'd. And 'tis remarkable, that this happen'd in a cold, northern sea.

One who made a considerable stay about *Manar*, told me, he learn'd from the divers, that in some places thereabouts, there grows at the bottom, in plenty, a sort of trees bearing leaves, almost like those of laurel, as also a certain fruit.

I was, likewise, informed by an eye-witness, that near the coast of *Mosambique* in *Africa*, there grows at the bottom of the sea, numerous trees, bearing fruit; which he describes to be very like that which in *America* they call *Acayu*; the leaves also resembling those of that tree.

But the most acceptable information I could procure about submarine plants, is that which concerns the famous *Maldivian*, or *Cocoa* nut, so highly esteem'd in the *East*, that, as some write, it is a great present from one king to another; and is besides greatly commended in *Europe* by physicians; for, the origin of this dear drug

is almost as much controverted, as its alexiterial virtues are extoll'd. NAT.HIST.

A man of learning, who had resided upon the spot, told me, he often heard from the divers, that there are real nuts or fruit, bore by a sort of cocoa-trees growing at the bottom of the sea; and that they are thence either torn off by the agitation of the water, or gather'd by the divers. This fruit is smaller than most other sorts of cocoa's, whose maturity they do not seem to arrive at. He thinks the species may have been very different from what it is; and have come from nuts fallen into the sea; together with the ruin of some little islands undermined by the water, and so drowned: of which, he told me, he saw three or four instances; during his stay there. He added, that whilst the fruit was under water, they observed no distinct shell and kernel; but the entire nut was so soft, that it might be easily cut with a knife, and was eaten like their other fruits; that being kept, for about a week, in the hot air, it grows solid and so hard, as to require steel tools to work upon it; and lastly, that tho' even upon the place, the fairer sort be of very great esteem, yet there are none of such prodigious price as is given out. He presented me with one, about the bigness of a large egg, and a fragment of another; which are both very hard. \*

\* Count *Marfigli* has, from his own experience, wrote a very voluminous, physical essay, upon the natural history of the sea; and therein occur abundance of curious particulars, relating to this subject: some sketches whereof *M. Fontanelle* gives us in his history of the Royal Academy, for the year 1710.







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# PREFACE.

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THE great advantages of chymistry, and its succeeding applications, both to philosophy and medicine, seem to be very little known or considered, by the generality of mankind. From a liberal towards the clearing of this matter, and supply of an assertion, which, thro' a false notion of chymistry, has been cast upon our excellent author.

# CHYMISTRY.

We are to observe, with an ancient writer, that "chymistry may be divided into three ranks: such as look after the knowledge of nature in general: such as seek out and prepare medicines: and such as search after riches, by transmutations, and the great virus. The two last, says that

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...pounding, and changing the part of things, and in so doing the admirable powers of nature, in the raising of acids, confluences, vapours, colours, and virtues of bodies, and from their labours, the true philosophy is like to receive the most improvement. But the pretensions of the third rank are not only to endow us with the benefits of staid life, but much immortality as well; and their success has been as small as their design was extravagant; — but certainly, if they could

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CHYMISTRY.

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# THE P R E F A C E.

**T**HE great advantages of chymistry, and its exceeding usefulness both to philosophy and medicine, seem to be very little known, or considered, by the generality of mankind.

For this reason, and because Mr. Boyle has been censured by some learned men, for cultivating an art which they apprehended to be unworthy of him, I would willingly offer something, from others, towards the clearing of this matter, and wiping off an aspersion, which, thro' a false notion of chymistry, has been cast upon our excellent author.

We are to observe, with an eminent writer, that “ chymists  
“ may be divided into three ranks: such as look after the know-  
“ ledge of nature in general; such as seek out and prepare  
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“ learned prelate, have been very successful in separating, com-  
“ pounding, and changing the part of things; and in shewing  
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“ their labours, the true philosophy is like to receive the noblest  
“ improvements. But the pretensions of the third kind are not  
“ only to endow us with the benefits of this life, but with im-  
“ mortality it self; and their success has been as small as their  
“ design was extravagant; — but certainly, if they cou’d  
“ be



“ be brought to content themselves with moderate things; to  
 “ grow rich by degrees; and not to imagin they shall gain the  
 “ Indies out of every crucible; there might be wonderful things  
 “ expected from them. And of this we have good assurance by  
 “ what is come abroad from divers eminent persons; among  
 “ whom some are members of the Royal Society. And if it were  
 “ not already excellently perform’d, I might speak largely of  
 “ the advantages that accrue to physick, by the industrious la-  
 “ bour of such chymists, as have only the discreet and sober  
 “ flame; and not the wild lightning of the others brains.” \*

Of the art, as ’tis pursued by the third kind of chymists, I shall here take no notice; but only as ’tis happily practis’d by the other two.

The office of chymistry is, by the application of fire, to separate the parts of natural bodies into distinct parcels; and, by means of the same agent, to unite the parts of others into one whole. This is, nearly, the definition of that judicious chymist, M. Homberg.

Now the operations of chymistry being generally perform’d in transparent vessels, upon known bodies, by known efficientes, it is an art that, at first sight, bids fair for improving both physick and philosophy; since it easily presents us with a great variety of resolutions and compositions; and shews us the several steps that are taken to produce them. There are numberless bodies in nature, which the fire actually divides into several parts, according to their different degrees of volatility, gravity, or attraction; and unites others, as the texture, figure, and the attractive power of their parts determine. Hence, therefore, we have an opportunity of viewing nature, either in a more simple, or a more complex state than that wherein she, of her self, appears. And this must necessarily lead to some discovery of the properties of different bodies; whereby philosophy will be improved: and as the different parts, and different combinations of animal, mineral, and vegetable substances, have different medicinal virtues; physick will, by this means, receive improvement also.

\* Dr. Sprai’s Hist. of the Royal Society. p. 37.

*"The best way of explaining nature, says M. Fontanelle, is to imitate her, and make her, by art, produce the same effects from known causes, which we our selves can put in action. By this means we become witnesses of the phenomena, and the several steps taken to produce them; and may, if the analogy be just, safely conclude, that the natural phenomena have the same origin with the artificial."*

*But no art can so well as chymistry, imitate the more abstruse and hidden operations, and phenomena of nature. Thus by familiar and obvious examples, it shews us how lightning, and the Aurora borealis, are producible; these being exquisitely resembled by Phosphorus: by some easy experiments of sublimation and precipitation, it shews how the odd effects of the plague may be suddenly produced and stopt; and it accounts for many other strange phenomena, which seem inexplicable by any other means than what this art affords.*

*'Tis well observed by the learned Boerhaave, that "all the changes which a body undergoes, are made by motion; and therefore, says he, we must search into its causes, and learn the manner whereby it may be excited, changed, and stopp'd. But these powers lie out of the reach of the human mind; unless from the observation of evident effects, they first appear to the senses." "We cannot, therefore, do better," continues he, "than to fix our eyes upon those motions, which arise when bodies begin to act contiguous to others. Now, to apply one body to another, again to separate them, and by the force of fire to give them their proper motion, must be a most effectual means to gain the knowledge of the powers of bodies. And this is the whole office of chymistry, which must, therefore, be an excellent instrument in the hands of a philosopher, who knows how to apply it; and the best that is known to reveal the secrets of nature."\**

*Chymistry, indeed, has been wretchedly abused; and great masters in the art, have strain'd and applied it to purposes for which it seem'd never design'd.*

\* Boerhaave in Serm. Acad. de Chemiâ suos errores expurgant. A. 1718. p. 15.

*The general fault committed herein, was, that from a few casual experiments, they would needs account for all the diseases in the human body, all the phenomena of nature, and all the mysteries of religion: for chymistry has had its enthusiasts. And doubtless, as managed by them, it has been the occasion of much mischief in the world.*

*These errors, however, are not to be attributed to the art, but to the artists. And if some chymists have introduced errors into this art, they are happily expunged by others; as the diligent Boerhaave, in a set discourse, has abundantly proved.\**

*In short, chymistry is another thing than what it formerly was; it has now made ample amends for all the darkness and obscurity wherein it formerly involved the world. Their's were the clouds and smoke, but ours the flame and the light.*

*Let any man compare the Prælectiones Chymicæ of Dr. Freind, with the common Tyrocinia of chymical writers; the treatises of M. Homberg, with those of Tachenius; and the chymical pieces of Mr. Boyle, with those of Helmont; and he will be sensible of this difference.†*

*Who can read the accounts, which Messieurs Homberg, Lemery, and the illustrious Newton, give of the action of the sun, and of fire, upon bodies, without being surpriz'd and delighted, at the prospect it opens; and at the great length whereto, in solid and experimental grounds, it carries us in philosophy? These great men evidently demonstrate, that fire is a grand, and an active principle in nature; that dashing against bodies, 'tis absorbed by them; that lodging it self therein, it becomes the cause of all the light they give us; and that were it not for this admission of its rays, our fluids would be solids, and our water ice.*

*M. Homberg shews, that the rays of the sun exercise an actual force, or trusion; for he found, that a very light body,*

\* Serm. Academ. de Chemiâ.

† Qui Hombergiana Tachenio, Helmontio Boyleana; qui vulgatos tyrociniorum scriptores contulerit cum iis quæ in miscellaneis Germanorum, in monumentis Gallicis, in Britannicis jam habentur commentariis, prudens ferat judicium; nec justum hujus calculum reformidabo. Boerhaave in Serm. Acad. de Chem. p. 21.



exposed to the focus of a burning-glass, would be turned over upon the matter whereon 'twas laid; and that the rays, thrown, by starts, thro' a small lens, upon the spring of a watch, straiten'd and stuck with one end into a board, made it vibrate; as if it had been push'd with a stick. ||

"The sun, says M. Lemery, may be considered as the grand reservoir of luminous matter; and all inflammable bodies, as little reservoirs subservient to him; that, as so many little suns, occasionally supply our necessities."

M. Homberg farther shews us, that "the light of the sun impinging against terrestrial bodies, modifies them according to their several textures: thus some, as water, it easily keeps fluid; of others, it forms oily, unctuous bodies; and makes inflammable substances of salts, of earth, and of water; none of which are, of themselves, inflammable; so that the other chymical principles of bodies, serve chiefly to detain this, or to be changed by its actions upon them." "The luminous matter," according to the same excellent chymist, "insinuates it self into the substance of bodies, to produce their sulphur; changes the arrangement of their parts; increases them, and, by consequence, alters the substance of the body it self, after as many different manners, as in different quantities it can be differently placed; whence proceeds an infinite variety. So that, would we compare the variety of the materials which exist, with those which might be brought into being, by all the combinations possible to be made; we must say, that the universe, so far as we know of it, is but very small, in comparison of what it might be; and that, if there were several worlds, formed like this of ours, they might all be differently furnished with objects, without changing either the manner, or the matter of the bodies, whereof they should consist: which demonstrates an infinite contrivance and power in the Being who made the universe."

And a still greater philosopher, prompted by chymical experiments, demands, whether "gross bodies, and light, are not

“convertible into one another; and may not,” says he, “bodies receive much of their activity, from the particles of light which enter their composition? For all fixed bodies, being heated, emit light, so long as they continue sufficiently hot; and light mutually stops in bodies, as often as its rays strike upon their parts. I know no body less apt to shine, than water; yet water, by frequent distillations, changes into fixt earth, as Mr. Boyle has tried; and then this earth, being enabled to endure a sufficient heat, shines by heat like other bodies.”

And to shew to what noble purposes such considerations may serve, I shall add, from the same great philosopher, that “the sun’s heat is as the density of its rays; that is, reciprocally, as the square of the distance of the place from the sun; and therefore, since the distance of the comet, in the year 1680, (that comet being on the 8th of December, in its perihelion,) was from the sun’s centre, to the distance of the earth from the same, as about 6 to 1000; the sun’s heat at the comet, was, then, to the summer’s heat with us, as 28,000 to 1. But the heat of boiling water, is about three times as great, as the heat that dry earth receives from the summer’s sun; and the heat of glowing iron, is three or four times greater than the heat of boiling water; consequently, the dry earth in this comet, in its perihelion, might receive a heat from the sun’s rays, 2000 greater than that of red-hot iron: a heat sufficient, immediately to dissipate and consume all manner of vapours, exhalations, and volatile substances!

“This comet, therefore, received an immense degree of heat from the sun; and this heat it might preserve for a very long time. A sphere of glowing iron, one inch in diameter, will scarce lose all its heat in the space of an hour, when exposed to the air; and a larger sphere would longer preserve its heat, in proportion to its diameter: whence a globe of red-hot iron, equal to our earth, that is about 40,000,000 feet in diameter, would require 50,000 years to cool in.”\*

\* Newton. Princip. p. 466, 467.

By such a remarkable instance, I chose to shew the great usefulness of chymistry to philosophy; for 'tis the peculiar province of chymistry, to consider the properties and the effects of fire and heat. And it were easy to bring other examples, to manifest what great improvements may be made in philosophy, by means of chymistry.

But because we here chiefly rely upon authorities, to encourage and recommend this study; that great restorer of learning, the Lord Verulam, tells us expressly, that "in discovering the mysteries of nature, we must make experiments by fire; and that chymistry is the principal art to perfect natural history, and to advance medicine." And of the truth of this doctrine his lordship has given substantial proof, particularly in his account of the nature of fire and flame; a subject, which has since been so advantageously prosecuted by M. Homberg, M. Lemery, some German chymists, Mr. Boyle, and the great Sir Is. Newton; that they seem to have left little for the industry of future ages to discover in it.

And Mr. Boyle, we may safely say, had never been that eminent philosopher he was, were it not for the assistance of chymistry; an art, wherein he greatly delighted, and earnestly recommends for the uses of philosophy, and the purposes of life. Let any one carefully read his following pieces; or the foregoing ones upon nitre; fluidity and firmness; volatility and fixedness; and other particular qualities of bodies; all which are wholly built upon chymical experiments; and then declare, whether chymistry has not been, thro' ignorance of its worth, unjustly accused; and whether it is not a most useful branch of natural philosophy.

The testimony of Dr. Freind too, who well understands the nature and use of chymistry, ought not to be omitted upon this occasion. His diligent searches into this art, have plainly shewed him, that, notwithstanding the ill use which has sometimes been made of it, a thorough knowledge therein might be vastly advantageous to the theory, as it has already been useful to the practice of physic.\*

\* Freind. Emmenolog. Præf.



But if any one shall still retain a doubt of the worth and abilities of chymistry, to reward those who cultivate it; let him consider the practice and procedure of the happiest philosopher the world ever yet could boast, the great Sir Isaac Newton; who, when he demonstrates the laws, the actions, and the powers of bodies, from a consideration of their effects, always produces chymical experiments for his vouchers; and when, to solve other phenomena, he makes use of these powers, his refuge is to chymistry; whence he manifestly shews, that without the assistance of this art, even he could hardly have explained the peculiar nature and properties of particular bodies.\*

That chymistry has furnished the shops with many excellent preparations, and such as have several advantages over the common Galenic remedies, is now too generally allow'd, to need that particular examples should be produc'd of it. That this art, also, meliorates several metalline and mineral bodies, and supplies many substances, useful in particular trades, and in several occurrences of human life, is a matter of fact acknowledg'd by all who are acquainted with the art, and its productions; so that it were time mispent, by an induction of more particulars, to shew its usefulness to mankind, both in philosophy and physic.

'Tis evident, therefore, that nothing but an intire ignorance of chymistry can cause it to be ill spoken of; and that it is so far from being an employment unworthy of a gentleman and a philosopher; that it is one of the principal whereto he ought to addict himself, who wou'd improve either philosophy or physic.†

\* Desino igitur sed in eo, in quo ultimam perspicientiæ humanæ metam posuisse videtur natura, *Isaaco Newtono*. Ille, licet adeo felix ut cum vivente de principatu in philosophiâ contendat nemo sanus, quando leges, actiones, vires corporum ex perpenfis demonstrate effectis, non aliud quam chemiam allegat; quando inventas ibi vires iterum extricandis applicat phænomenis, mera chemica advocat, claroque testatur exemplo, abfuisset chemia, singularium corporum propriam indolem, proprias vires, vix potuisse mortalium perspicacissimo cognosci. *Boerhav. Serm. Acad. de Chemiâ, p. 39, 40.*

† In physicis nil desperandum hæc (i. e. chemiâ) duce; omnia bona ab hac speranda in medicis; abditissima revelare, extricare impedita, latentes corporum vires detegere, imitari, dirigere, mutare, applicare, perficere, docet fidelissimè. *Boerhav. Serm. de Chem. p. 38, 39.*

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T H E  
SCEPTICAL CHYMIST:  
O R,  
C O N S I D E R A T I O N S

U P O N T H E

Experiments usually produced in favour  
of the four elements, and the three  
chymical principles of mixed bodies.

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S E C T. I.

**N**Otwithstanding the subtle reasonings of the *Peripatetics*, and the pretty experiments of the chymists, I am so diffident as to think, that if neither can produce more cogent arguments, for the truth of their assertion, than are usually given; a man may reasonably doubt as to the number of those material ingredients of mixed bodies, which some call elements, and others principles.

*The number  
of the Peripa-  
tetic elements,  
and chymical  
principles  
doubtful.*

Indeed, when I consider'd, that these principles are as essential in natural philosophy, as the real elements themselves are in the universe; I expected to find them solidly established. But upon impartially examining the bodies themselves, which are said to result from the blended elements; and torturing them into a confession of their constituent principles; I was quickly induc'd to think, that the number of them had been contended for with more earnestness than success.

The words element, and principle, are here used as equivalent terms; and signify those primitive and simple bodies, of which the mix'd ones are said to be compos'd; and into which they are ultimately resolv'd.

*Elements and  
principles,  
what?*

Tiss

## Chymistry.

Arguments  
for the four  
elements

'Tis said, that a piece of green wood, by burning, discovers the four elements of which mixed bodies are composed: the fire appearing in the flame, by its own light; the smoak ascending, and readily turning into air, as a river mixes with the sea; the water, in its own form, boiling out at the ends of the stick; and the ashes remaining for the element of earth.

This doctrine of the four elements is, also, said to have been deliver'd by *Aristotle*, as the result of his study and application, in comparing the theories of the former philosophers; and that it has, ever since, been universally embraced by men of learning, till *Paracelsus*, and a few other chymists, deny'd it, and asserted only three principles, which they endeavoured to disguise by the terms, salt, sulphur, and mercury.\*

Considered.

But by this experiment it shou'd appear, that the elements are made of mix'd bodies, rather than mix'd bodies of the elements. For in wood, thus analyz'd, and other bodies dissipated and alter'd by the fire, it appears, that the supposed elementary fire and water are made out of the concrete; not that the concrete was made up of fire and water. And, it has never, that I know of, been prov'd, that nothing can be obtained by committing a body to the fire, that was not pre-existent in the body.

'Tis true, when a refiner, mixing gold and lead, exposes them upon the cupel to a violent fire; he thereby separates the mixture into its component ingredients, gold, and lead, which, driven off with the dross of the nobler metal, makes litharge of gold.

But then we do not see nature pull down a parcel of the element of fire from, where 'tis fancied to be plac'd, near the orb of the moon, and blend it with a quantity of each of the three other elements, to compose every mix'd body; as we see the refiner take both gold and lead to compose the mals we speak of. Besides, it remains to be proved, that the fire only takes the elementary ingredients asunder, without causing any other alteration; for otherwise, bodies may afford substances which were not pre-existent in them; as flesh, too long kept, produces maggots, &c. Now that the fire does not always barely separate the elementary parts, but, sometimes at least, alters the ingredients of

\* The judicious *M. Homberg*, who has greatly improved the art of chymistry, or rather, advanced a new one, gives us the following account of the three chymical principles. The saline principle is, according to him, a matter soluble in water, and unresolvable by the fire; being the acid substance, and general basis of all salts; tho' never to be found in a pure and unmixed state.

This author, by numerous experiments, made with the utmost care, cou'd never obtain any sulphureous principle from

bodies; and brings several arguments to prove, that such a principle is, in reality, fire or light, striking against, residing in, and acting upon bodies.

The principle, mercury, is, according to the same candid chymist, a real quick-silver, or liquid substance, perfectly resembling a fluid metal; being nearly of the same weight with silver, and wetting nothing but metals. See *French Memoirs*, A. 1702. p. 4. A. 1705. p. 117. A. 1708. p. 404. A. 1709. p. 133.



bodies, appears probable from the instance given; wherein there is nothing elementary separated, by the great violence of the refiner's fire: the gold and lead, which are the two ingredients separated by the analysis, being yet perfectly mix'd bodies; and the litharge being lead indeed, but such as is different in consistence, and other qualities, from what it was before. And I have, sometimes, seen parcels of glass adhering to the test, or cupel; which proceeding, as well as the gold or litharge, from the analysis, is not, surely, a third ingredient produced out of the mass by the fire.

But, there are many bodies, from whence it seems impossible to extract four elements by fire: and which of them can be obtained from gold, by any degree of fire whatsoever? Nor is gold the only body in nature, that would puzzle a bare *Aristotelian* to analyze, by the fire, into elementary bodies: for ought I have yet observ'd, silver calcin'd, *Venetian* talc, &c. are so fixed, that to reduce any of them into four heterogeneous substances, has hitherto prov'd a task much too hard even for chymists.

And as there are several bodies, not reducible, by fire, into so many as four heterogeneous ingredients; so, there are others which may be reduced into more: human blood, and that of other animals, yield five distinct substances; phlegm, spirit, oil, salt, and earth; as experience testifies.

To proceed farther; it seems probable, that at the first production of mixed bodies, the universal matter, whereof they consist, was actually divided into little particles of several sizes and shapes, variously mov'd.

*The matter of all bodies originally divided into small particles, of different shapes and sizes.*

Besides what happens in the generation, corruption, nutrition, and decrease of bodies; microscopes, by discovering the extreme minuteness of the scarce sensible parts of concretes; chymical resolutions of mixed bodies, and many other operations of fire upon them, seem sufficiently to manifest, that they consist of parts very minute, and of different figures: and that there also intervenes a various local motion of such small bodies, will scarce be denied; whether we grant the origin of matter assigned by *Epicurus*, or that related by *Moses*. For, the first supposes, both mixed bodies, and all others, to be produced by the various, casual occurrences of atoms, moving themselves, every way, by an internal principle, in the infinite *Vacuum*. And the inspired historian informs us, that the great and wise author of things, did not immediately create plants, beasts, birds, &c. but produced them out of those portions of the pre-existent created matter, which he calls water and earth; and allows us to conceive, that the constituent particles, whereof these new concretes were to consist, must have been variously moved, in order to be connected into the bodies they were, by their various coalitions and textures, to compose.

'Tis also possible, that of these minute particles, many of the smallest and contiguous ones associated into minute masses; and by

*These particles might unite into small masses, not easily separated again.*

Chymistry.

their coalitions, constituted such numerous, little, primary concretions, as were not easily separable into the particles that composed them.

Gold will mix and fuse, not only with silver, copper, tin, and lead; but with antimony, *Regulus Martis*, and many other minerals; and thereby compose bodies, very different both from gold, and the other ingredients of the resulting concretes. The same gold may also, by common *Aqua regia*, and several other menstrua, be reduc'd into a seeming liquor; so that the corpuscles of the metal will, with those of the menstrua, pass thro' paper; and with them coagulate into a crystalline salt. And further, with a small quantity of a certain saline substance, I can easily sublime gold into the form of long crystals: and by many other ways may gold be disguiz'd, and help to constitute bodies of very different natures, both from it self, and from one another; yet be afterwards reduced to the same numerical, yellow, fixed, ponderous, malleable substance, it was before its mixture. And not only the most fixed, but also the most fugitive of metals, conspires to favour our assertion; for quick-silver will, with several metals, compose an amalgam; with several menstrua, it seems to be turned into a liquor; with *Aqua fortis*, it will be brought into either a red, or a white precipitate; with oil of vitriol, into one of a pale yellow; with sulphur, it will compose a blood-red volatile cinnabar; with some saline bodies, it will ascend in form of a salt, dissoluble in water; with *Regulus* of antimony, and silver, I have seen it sublim'd into a kind of crystals; with another mixture, I reduced it into a malleable body; and into a hard brittle substance by another: and some there are, who affirm, that by proper additions, they can reduce quick-silver into an oil; nay, into glass; yet out of all these compounds, we may recover the very same running mercury, that was the principal disguiz'd ingredient of them. Hence it appears not absurd to conceive, that little primary masses, or clusters, may remain undissipated, notwithstanding they enter the composition of various concretions; since the corpuscles of gold and mercury, tho' not primary concretions of the most minute particles of matter, but confessedly mix'd bodies, are able, plentifully, to concur to the composition of several very different bodies, without losing their own nature, or texture, or having their cohesion violated by the loss of their associated parts, or ingredients.\*

And

\* Concerning the nature, and various forms of bodies, and the sulphur they contain, take the words of one, who seems thoroughly to have consider'd them. "Altho' a pseudo-topaz, says Sir Is. Newton, a Selenites, rock-crystal, island-crystal, vulgar glass, (that is, sand melted together,) and glass of an-

"timony; which are terrestrial, stony, "alcalizate concretes; and air, which, "probably, arises from such substances "by fermentation; be substances very "differing from one another in den- "sity; yet they have their refractive "powers almost in the same propor- "tion to one another, as their densities; "except-

And as confidently as some chymists, &c. object against the *Peripatetics*, that from the mixture of their four elements, there could arise but an inconsiderable variety of compound bodies; yet if the *Aristotelians* were half so well vers'd in the works of nature, as in the writings of their master, this objection would not triumph for want of experiments to shew the contrary. For if we assign to the corpuscles, whereof each element consists, a peculiar size and shape,

*Chymistry.*

*A great variety of compounds may arise from a few ingredients.*

“excepting that the refraction of that strange substance, island-crystal, is a little bigger than the rest. And particularly air, which is 3500 times rarer than the pseudo-topaz, and 4400 times rarer than glass of antimony, and 2000 times rarer than the selenites, glass vulgar, or crystal of the rock, has, notwithstanding its rarity, the same refractive power in respect of its density, which those very substances have with respect to theirs; excepting so far as those differ from one another. Again; the refraction of camphire, oil-olive, linseed-oil, spirit of turpentine and amber; which are fat, sulphureous, unctuous bodies; and a diamond, which, probably, is an unctuous substance coagulated, have their refractive powers in proportion to one another, as their densities, without any considerable variation. But the refractive powers of these unctuous substances are two or three times greater, in respect of their densities, than the refractive powers of the former substances, in respect of theirs. Water has a refractive power in a middle degree, between those two sorts of substances; and, probably, is of a middle nature; for out of it grow all vegetable and animal substances; which consist as well of sulphureous, fat, and inflammable parts, as of earthy, lean, and alcalizate ones. Salts and vitriols have refractive powers in a middle degree, between those of earthy substances and water; and, accordingly, are composed of those two sorts of substances. For by distillation, and rectification of their spirits, a great part of them goes into water; and a great part remains behind, in the form of a dry, fixed earth, capable of vitrification. Spirit of wine has a refractive power in a middle degree,

“between those of water and oily substances; and, accordingly, seems to be composed of both, united by fermentation; the water, by means of some saline spirits, with which 'tis impregnated, dissolving the oil, and volatilizing it by the action. For spirit of wine is inflammable, by means of its oily parts; and being distilled often from salt of tartar, grows by every distillation more and more aqueous and phlegmatic. And chymists observe, that vegetables, distilled *per se*, before fermentation, yield oils without any burning spirits; but after fermentation, yield ardent spirits, without oils; which shews, that their oil is by fermentation converted into spirit. They find also, that if oils be poured, in small quantity, upon fermenting vegetables, they distil over, after fermentation, in the form of spirits. “Since then all bodies seem to have their refractive powers proportional to their densities, or very nearly, excepting so far as they partake more or less of sulphureous, oily particles; and thereby have their refractive powers made greater; it seems rational to attribute the refracting power of all bodies, chiefly, if not wholly, to the sulphureous parts with which they abound. For it's probable, that all bodies, more or less, abound with sulphurs. And as light, congregated by a burning glass, acts most upon sulphureous bodies, to turn them into flame and fire; so, since all action is mutual, sulphurs ought to act most upon light. For that the action between light and bodies is mutual, appears, in that the densest bodies, which refract and reflect light most strongly, grow hottest in the summer sun, by the action of the refracted or reflected light.” *Newton. Optic. p. 248—251.*



*Chymistry.*

it were eafie to fhew, that fuch differently figured corpuscles, may be mixed in fuch various proportions, and be connected fo many feveral ways, that an almoft incredible number of variously qualified concretes, may be compofed of them. Nay, the corpuscles of one element, may barely, by being associated among themfelves, make up little mafles of a different fize and figure from their conftituent parts; whilft to the ftrict union of fuch minute bodies, there often feems nothing requifite, but the bare contaft of a great part of their fufaces. And how great a variety of phenomona, the fame matter, without the addition of any other, only feveral ways difpofed or rang'd, is able to exhibit, may appear by the multitude of different engines, which, by the contrivance of skilful mechanics, and the dexterity of expert workmen, might be made of iron alone. But, in our cafe, being allowed to deduce compound bodies from four very differently qualified forts of matter; what we faid of new concretes refulting from the mixture of incorporated minerals, will not admit it to be doubted, that four elements, managed by the skill of nature, may afford a multitude of different compounds.

But the *Aristotelian* hypothefis, is not comparable to the mechanic doctrine of the bulk and figure of the fmalleft parts of matter; for from thefe more univerfal and fruitful principles of the elementary matter, may fpring a great variety of textures; upon whole account, a multitude of compound bodies, might greatly differ from one another. What is here faid of the four *Peripatetic* elements, may be alfo applied, *mutatis mutandis*, to the chymical principles. And both of them muft, I fear, call in to their affiftance, fomething that is not elementary, to excite, or regulate the motion of the parts of matter, and difpofe them after the manner requifite to conftitute particular concretes.

*Various fub-  
ftances obtain-  
able from bo-  
dies, by fire.*

From moft of thofe mixed bodies, which partake either of an animal, or a vegetable nature, there may, perhaps, by the help of the fire, be obtained a determinate number of fubftances, deferving different denominations.

The truth of this affertion feems manifef, or, however, will fufficiently appear hereafter.

It may, likewise, be granted, that thofe diftinct fubftances, which concretes either generally afford, or confift of, may, without great inconvenience, be called the elements, or principles of them.

*Whether fire  
be the proper  
inftrument for  
analyzing mix-  
ed bodies?*

Notwithstanding what common chymifts have taught, it may reafonably be doubted, how far, and in what fenfe, fire ought to be efteemed the genuine and univerfal inftrument of analyzing mixed bodies.

It were to be wifh'd, our chymifts had told us clearly, what kind of divifion of bodies by fire, muft determine the number of the elements; for it is not near fo eafy, as many think, to determine diftinctly the effects of heat. Thus guaiacum, for inftance, burnt with

with an open fire, is reduced into ashes and soot; tho' the same wood, distilled in a retort, is resolv'd into oil, spirit, vinegar, water, and charcoal; the last whereof, to be reduced into ashes, requires a farther calcination than can be given it in a close vessel. Again; having kindled amber, and held a clean, concave, smooth vessel, over the smoke of its flame; I found the soot, into which that fume condens'd, to be very different from any thing I had observed to proceed from the steam of amber, purposely distill'd *per se*, in close vessels. Thus, having kindled camphire, and catch'd the smoke that plentifully ascended out of the flame, it condens'd into a black and unctuous soot; which would not have been guess'd by the smell, or other properties, to have proceeded from camphire: but exposing a quantity of that fugitive concrete, to a gentle heat, in a close, glass vessel; it sublimed up, without seeming to have lost any thing of its whiteness or nature; both which it retained, tho' I afterwards so increased the fire, as to bring it to fusion. And besides camphire, there are several bodies, in which the heat in close vessels makes no separation of heterogeneous parts, but only a comminution; those that rise first being homogeneous with the others, tho' subdivided into smaller particles; whence sublimations have been stiled the pestles of the chymists. Common brimstone, once or twice sublimed, and submitted to a moderate fire in subliming pots, rises all into dry, and almost tasteless flowers; tho', being expos'd to a naked fire, it affords much of a saline, fretting liquor. And as it is considerable in the analysis of mixed bodies, whether the fire acts on them, while they are expos'd to the open air, or shut up in close vessels; so the degree of fire, by which we attempt the analysis, is of no small moment; for a mild *Balneum* will separate unfermented blood, for instance, only into phlegm, and *Caput mortuum*. In making sope, the salt, the water, and the oil, or grease, whereof that factitious concrete consists, being boiled up together, are easily brought to mix and incorporate into one mass, by one degree of heat; but the same mass may be again divided into an oleagenous, an aqueous, a saline, and an earthy part, by a greater. And so we may observe, that impure silver and lead, being exposed together to a moderate fire, will, thereby, be fused into one mass, and mixed *per minima*; tho' a much more vehement fire would carry off the baser metal. Besides, when a vegetable, abounding in fix'd salt, is analyz'd by a naked fire; as one degree of heat will reduce it into ashes, so by only the farther increase of fire, those ashes may be turn'd into glass. And, by the way, if ashes pass for an element, because they are producible by one degree of fire; why may not glass be one of the elements of many bodies, since that, also, may be obtained barely by the fire? By a proper method of applying the fire, such similar bodies may be obtained from a concrete, as chymists have not been able to separate, barely by burning it in an open fire, or by barely distilling it in

Chymistry.

*Chymistry.* close vessels. To me it seems very considerable, tho' it is greatly overlook'd, that from any of the common ways of distillation in close vessels, no separation is made of such a volatile salt as wood affords, when 'tis first, by an open fire, divided into ashes and soot, and that soot is afterwards plac'd in a strong retort, and compell'd, by an urgent fire, to part with its spirit, oil, and salt; for tho' I dare not peremptorily deny, that in the liquors of guaiacum, and other woods, distill'd in retorts after the common manner, there may be saline parts, which, by reason of the analogy, may pretend to the name of some kind of volatile salt; yet, questionless, there is a great difference betwixt such salts, and that we have, sometimes, obtain'd upon the first distillation of soot. For we cou'd never yet see separated from woods, analyz'd only after the vulgar manner, in close vessels, any volatile salt in a dry and saline form, as that of soot; which we have often had very crystalline and geometrically figured. And then as the saline parts of the spirits of guaiacum, &c. appear sluggish upon distillation, the salt of soot seems to be one of the most volatile bodies in nature; and if it be well made, will readily ascend with the mild heat of a furnace, warm'd only by the single wick of a lamp, to the top of the highest glass-vessels, commonly made use of for distillation. Besides all this; the taste and scent of the salt of soot are exceeding different from those of the spirit of guaiacum, &c. for the former, not only smells and tastes much less like a vegetable salt, than like that of harts-horn, and other animal concretes; but in many other properties seems more allied to the family of animal, than to that of vegetable salts. I might shew, by other examples, that the chymists, to have dealt clearly, ought to have more explicitly and particularly declared, by what degrees of fire, and in what manner of application of it, they wou'd have us judge a division, made by its means, to be a true analysis into their principles. But I proceed to mention other particular reasons why I doubt, whether fire be the true and universal analyzer of mix'd bodies.

In the next place, I observe there are some mix'd bodies, from which it has not yet been made appear, that any degree of fire can separate either salt, or sulphur, or mercury, much less all the three. The most obvious instance of this truth is gold; a body so fix'd and wherein the elementary ingredients, if it has any, are so firmly united to each other; that we find not in the operations, wherein gold is exposed to the most vehement fire, that it, discernibly, so much as loses of its fixedness or weight; so far is it from being resolv'd into those principles, whereof one, at least, is acknowledg'd to be fugitive. *Gasto Claveus*, who, tho' a lawyer by profession, seems to have had no small curiosity and experience in chymistry, relates, that having put into one small earthen vessel an ounce of the most pure gold, and into another the like weight of pure silver, he placed them both in that part of a glass-house furnace, wherein the workmen keep their metal continually melted; and that having there kept both the gold  
and



and the silver in constant fusion, for two months together, he afterwards took them out of the furnace; and weighing both of them again, found, that the silver had not lost above a twelfth part of its weight, and the gold nothing at all.\*

And tho', perhaps, there be no other body so perfectly fix'd as gold; yet there are many others so compos'd, that I have not yet observ'd the fire to separate from them any one of the chymical principles. I need not relate what complaints the more candid and judicious chymists themselves make of those boasters, who confidently pretend, they have extracted the salt or sulphur of quicksilver, when they only disguise it, till it resembles the concretes, whose names are given it; whilst, by a skilful and rigid examination, it may be easily stript of its dress, and made to appear again in the pristine form of running mercury: these pretended salts and sulphurs being so far from elementary parts, extracted out of mercury, that they are rather re-compounded bodies, made up of the whole metal and the menstruum, or other additions. And as for silver, I never saw any degree of fire make it part with so much as one of its three principles. The experiment of *Claveus* might, indeed, give a suspicion, that silver may be dissipated by fire, provided it be extremely violent, and very lasting; yet it will not, necessarily, follow, that, because the fire was able, at length, to make the silver lose a little of its weight, it was, therefore, able to dissipate it into its principles; for I have observ'd little grains of silver to lie hid in the small cavities of crucibles, wherein that metal had been long kept in fusion; whence some goldsmiths of my acquaintance make a profit, by grinding such crucibles to powder, to recover out of them the latent particles of silver; and hence I might argue, that, perhaps, *Claveus* was mistaken, and imagin'd that silver to have been driven away by the fire, which, indeed, lay in minute parts, hid in his crucible; for so small a quantity as he mis'd, of so ponderous a body, might be easily conceal'd in the pores thereof.

But admitting, that some parts of the silver were driven away by the violence of the fire; what proof is there that it was either the salt, the sulphur, or the mercury of the metal, and not rather a part of it, homogeneous to what remain'd? For, besides that the silver left behind, seem'd not sensibly alter'd, which it, probably, wou'd have appeared, had so much of any one of its principles been separated from it; we find in other mineral bodies, of a less permanent nature; that the fire may divide them into such minute parts, as to carry them away with it self; without at all destroying their nature. Thus we see, that in the refining of silver, the lead that is mix'd therewith,

\* Gold exposed to the sun's rays, thrown to a point, either by a large glass lens, or a burning concave, will fume, be scattered, and dissipated into small drops, be vitrified, and lose of its weight;

whence, says M. Homberg, this noble metal is not so fixed as chymists commonly pretend: and thus, all metals are volatile with regard to a heat sufficiently vehement. See French Memoirs, A. 1702. p. 186—197.

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to carry away the copper, or other ignoble mineral that debases it, will, if let alone, evaporate in time, upon the test; but if, as 'tis most usual amongst such as refine great quantities of metals together, the lead be blown off from the silver, by bellows; that which wou'd, otherwise, have escaped in the form of unheeded steams, will, in great part, be collected near the silver, in the form of a darkish powder, call'd, litharge of silver. And thus *Agricola* informs us, when copper, or the ore of it, is fused by the violence of the fire with *Cadmia*; some of the sparks, which, in great multitudes, fly upwards, stick to the vaulted roofs of the furnaces, in the form of little white bubbles, which, therefore, the *Greeks* call *Pompholyx*; whilst others more heavy, partly adhere to the sides of the furnace, or fall to the ground; and by reason of their ashy colour, as well as weight, are termed *σποαί*. I might add, I have not found, that from *Venetian* talc, from the *Lapis Ossifragus*, or *Osteocolla*, from *Muscovy* glass, from pure and fusible sand, &c. such of my acquaintance as have try'd, were able, by the fire, to separate any one of the hypostatical principles. Glass, we know, is made by the pure colliquation of the salt and earth, remaining in the ashes of a burnt plant; yet common glass so far resists the violence of the fire, that most chymists think it a body less apt to be destroyed than gold it self. But if the artificer can so firmly unite such comparatively gross particles, as those of earth and salt, that make up common ashes, into a body indissoluble by fire; why may not nature associate, in several bodies, the more minute elementary corpuscles, too firmly, to let them be parted by the fire? Having put a quantity of camphire into a glass-vessel, and plac'd it in a gentle heat, I found it to sublime to the top of the vessel in flowers; without leaving the weight of a single grain behind: and these in whiteness, smell, &c. seemed not to differ from the camphire it self. *Helmont* affirms, that a coal, kept in a glass exactly closed, will not be calcined to ashes; tho' detain'd ever so long in a strong fire. And indeed, having sometimes distilled such woods as box; whilst our *Caput mortuum* remain'd in the retort, it continued black, like charcoal, tho' the retort were of earth, and kept red hot in a vehement fire; but as soon as ever it was brought out of that vessel into the open air, the burning coals would suddenly degenerate, or fall asunder, without the assistance of any new calcination, into pure white ashes. Lastly, 'tis known, that common sulphur, if pure, and freed from its vinegar, leisurely sublimed in close vessels, rises into dry flowers; which may be presently melted into a body, of the same nature with that which afforded them: tho' if brimstone be burnt in the open air, it yields a penetrating fume, which being caught in a glass-bell, condenses into that acid liquor, call'd, oil of sulphur *per campanam*. Hence it appears, that even among the bodies that are not fixed, there are several of such a texture, that the fire, as chymists employ it, cannot easily resolve them into elementary substances. For, some bodies being of such a texture, that the fire can drive

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drive them into the cooler part of the vessels, wherein they are included; and, upon occasion, remove them from place to place, so that they fly the greatest heat more easily, than it can divorce their elements, especially without the assistance of the air; we see, that our chymists cannot analyze them in close vessels: and from other compound bodies, the open fire can as little separate the elements; for what can a naked fire do to analyze a mix'd body, if its component principles be so minute, and so firmly united, that the corpuscles of it need less heat to carry them up, than is requisite to divide them into their principles\*? So that of some bodies, the fire cannot in close vessels, make any analysis at all; and others will, in the open air, fly away in the forms of flowers or liquors, before the heat is able to divide them into their principles. And this may hold, whether the various, similar parts of a concrete, be combined by nature, or by art; for in factitious sal-armoniac, we find the common and the urinous salts so well mixed, that both in the open fire, and in subliming vessels, they rise together as one salt; which seems in such vessels irresoluble by fire alone. For I have some sal-armoniac, which, after the ninth sublimation, still retains its compound nature. And, indeed, I scarce know any one mineral, from which, by fire alone, chymists sever any substance, simple enough to deserve the name of an element, or principle. For, tho' out of native cinnabar, they distil quick-silver; and tho' from many of those stones the ancients call'd *Pyrites*, they sublime brimstone; yet both that quick-silver, and this sulphur, being very often the same with common minerals, are themselves too compounded, to pass for the elements of these.

But further; there are many separations to be made by other means, which either cannot at all, or not so well, be made by the fire alone. When gold and silver are melted into one mass, it would lay a great obligation upon refiners and goldsmiths, to teach them the art of separating them by fire; † without the trouble and charge they are at

\* Hence it is, that the analysis of common sulphur proves so very difficult; for the principles whereof it is composed are so volatile, and so firmly connected together, that they are apt to rise at once. M. *Homburg*, however, found, that this mineral is resolvable into an acid salt, a very fixed earth, an unctuous, bituminous, and inflammable substance; and sometimes, a small quantity of metal, which he discover'd to be copper. The acid proved to be the same with that of vitriol. See *French Memoirs*, A. 1703. p. 36.

† The common way of separating gold from silver, when these two metals are mixed together, is, indeed, troublesome,

and expensive; but M. *Homburg* shews us a much more easy, and less chargeable, method, of doing it by fusion; which he accidentally discover'd. In order to reduce some very fine grains of a mixture of equal parts of gold and silver, into one lump, he put them into a crucible, at the bottom whereof lay about equal parts of salt-peter, and decrepitated salt; this crucible he placed in a melting furnace, with a gentle fire; and taking it out in a quarter of an hour's time, and suffering it to cool, he broke it; when, to his surprize, he found the gold in a lump at the bottom, the silver



*Chymistry.* at to do it; tho' they may be very easily parted by spirit of nitre, or *Aqua fortis*. Thus, likewise, the metalline part of vitriol, will not be so easily and conveniently separated from the saline, even by a violent fire, as by the affusion of certain alkaline salts, in a liquid form, upon the solution of vitriol made in common water. For hereby the acid salt of the vitriol, leaving the copper it had corroded, to join with the salts that were added; the metalline part will be precipitated to the bottom, almost like mud. The vulgar chymists have not been able, by fire alone, to separate pure sulphur from antimony; but tho' there are in their books many plausible processes for extracting it, yet he who shall make as many fruitless trials, as I have done, to obtain it by most of them, will be easily persuaded, that the productions of such processes are antimonial sulphurs, rather in name, than nature. But tho' antimony, sublimed by it self, is reduced only to a volatile powder, or to antimonial flowers, of a compound nature, like the mineral that affords them; yet I have, by a particular method, sublimed out of antimony, a larger proportion of sulphur, than ever I otherwise saw obtain'd out of that mineral. For, having digested eight ounces of fine pulverized antimony, with twelve ounces of oil of vitriol, in a well clos'd glass, for about six or seven weeks; and having caused the mass, now grown hard and brittle, to be distilled in a retort placed in sand, with a strong fire; we found the antimony to be so open'd, or alter'd, by the menstruum, where-with it had been digested, that tho' crude antimony, forced up by the fire, rises only in flowers, ours thus treated, afforded in the receiver, and at the top of the retort, about an ounce of sulphur, yellow and

silver in two pieces, and some grains above it, cover'd over with the salts. By repeated trials, M. *Hornberg* afterwards found, that to make the separation exact, the quantity of the metals ought to be nearly equal; and that the fire must not be violent. He farther observes, that the salts, whilst they are not in perfect fusion, sustain the mixed metal, when it begins to melt, and serve as a kind of sieve to it; permitting the heavier part, the gold, to pass through, and retaining the lighter, the silver, which in this case, is not so well fused as the gold. So that, if at the right juncture, the crucible be taken from the fire, the silver presently hardens; being become fine, upon separating from the gold, and cannot be fused again, without a violent fire. The salts, in the mean time, which sustain this silver, being but imperfectly fused, prevent the silver from falling to the bottom of the

crucible, and mixing again with the gold. *French Memoirs, A. 1713. p. 89, — 91.*

He, likewise, shews, that when silver is debased by copper, it may, with great ease and cheapness, be excellently purified, by calcining it with half its weight of common brimstone; and when the whole is melted together, throwing on, at several times, a sufficient quantity of the filings of iron, which quantity may be easily judged of in the operation. By this means, the sulphur will immediately leave the silver, and unite with the iron and copper; and turning to dross, float at the top, and leave the silver pure at the bottom of the crucible. The process must be stopp'd, as soon ever the iron is perfectly fused; otherwise, a part of the copper will be precipitated, and mixing with the silver, cause the work to be began afresh. *French Memoirs, A. 1701. p. 53 — 56.*

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brittle, like common brimstone; and of so sulphureous a smell, that, *Chymistry.* upon unluting the vessels, it infected the room with a fetor scarce supportable. This sulphur had also the perfect inflammability of common brimstone; and would immediately kindle at the flame of a candle, and burn blue like that. The long digestion, indeed, wherein our antimony and menstruum were detained, seem'd conducive to the better unlocking of the mineral; yet, by incorporating with powder'd antimony, a convenient quantity of oil of vitriol, and committing them immediately to distillation, there may be obtained a little sulphur, like the common, and more combustible than, perhaps, will at first be taken notice of. For I have observed, that after its being first kindled, the flame would sometimes go out too soon of it self; but if the same lump were held again to the candle, it would rekindle, and burn for a pretty while, even after the third or fourth extinction. As something sulphureous may be discover'd in oil of vitriol, 'tis natural to suspect, either that this substance was some sulphur which lay hid in that liquor, and was, by this operation only, reduced into a manifest body; or else, that it was a compound of the unctuous parts of the antimony, and the saline ones of the vitriol: because many would have sulphur to be only a mixture, made in the bowels of the earth, of vitriolic spirits, and a certain combustible substance\*. But the quantity of sulphur we obtained by digestion, was much too great to have been latent in the oil of vitriol; and that vitriolic spirits are not necessary to the construction of such a sulphur as ours, I could easily manifest, from the several ways by which I have obtained, tho' not in such plenty, a sulphur of antimony, colour'd and combustible like common brimstone. And to shew, that distill'd, vitriolic spirits, are not necessary to the obtaining of such a sulphur, as we have been considering; I did, by the bare distillation of spirit of nitre, from its weight of crude antimony, soon separate a yellow, and very inflammable sulphur; which, for ought I know, deserves as much the name of an element, as any thing the chymists separate from any mineral by the fire. And tho' the urinous and common salts, whereof sal-armoniac consists, remain'd, as we said, unsever'd by the fire, in many successive sublimations; yet, they may be easily separated, by pouring upon the concrete, finely powder'd, a solution of salt of tartar, or of the salt of wood-ashes; for, upon diligently mixing of these, a very strong scent of urine will ensue; and, perhaps, a sharp pain in the eyes, if held too near. Both these effects proceed from hence, that by the alkaline salt, the

\* M. Geoffroy shews, that the mixture of any vitriolic salts with inflammable substances, will yield common brimstone; and by the different compositions he has made of sulphur, and particularly from oil of vitriol, and oil of

turpentine; and by the analysis thereof, when thus prepared, he discover'd it to be nothing but the vitriolic salt, united with the combustible substance. *French Memoirs, A. 1704. p. 381.*

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sea-salt that enter'd the composition of the sal-armoniac, is rendred more fixed; and thereby a divorce is made between it, and the volatile, urinous salt; which being, at once, set at liberty, and put into motion, begins presently to fly away, and to offend the nostrils and eyes it meets with in its way. And if the operation of these salts be, in convenient glasses, promoted by warmth, even that of a bath, the ascending steams may easily be caught, and reduced into a penetrant spirit, abounding with a salt; which I have sometimes found to be separable in a crystalline form. I might add, that tho' sublimate, consisting of salts and quick-silver, combined and carried up together by heat, may be many times sublimed by a like degree of fire, without suffering any divorce of the component bodies; yet the mercury will be easily sever'd from the adhering salts. But I rather observe, what may seem strange, that by such an addition, as seems only to promote the separation, there may easily be obtained from a concrete, that by the fire alone is readily divisible into all the elements whereof vegetables are supposed to consist, a similar substance, that differs in many respects from them all. For I have practis'd a way, whereby common tartar, without the addition of any thing that is not perfectly a mineral, except salt-petre, may, by one distillation, in an earthen retort, be made to afford plenty of real salt, ready dissoluble in water; which I found to be neither acid, nor of the smell of tartar; and to be almost as volatile as spirit of wine; and, indeed, of a very different nature from all that is usually separated by fire from tartar.

The fire, even when it divides a body into substances of various consistences, does not commonly analyze it into hypostatical principles, but only disposes its parts into new textures; and thereby produces concretes, of a new, indeed, but compound nature. And this we shall abundantly make good hereafter.

Several distinct substances are obtainable from some concretes, without the assistance of fire; which no less deserve the name of elementary, than some which chymists extort by the violence of it.

We see, that the inflammable spirit of wine may not only be separated by the gentle heat of a bath, but may be distill'd, either by the help of the sun-beams, or even of a dunghill; being, indeed, of so fugitive a nature, that it is not easy to keep it from flying away, even without the application of external heat. I have likewise observed, that a vessel full of urine, being plac'd in a dunghil, the putrefaction, after some weeks, usually opens the body; so that the parts disbanding the saline spirit, will, within no very long time, if the vessel be not stoppt, fly away of it self; whence from such urine, I have been able to distil little or nothing, besides a nauseous phlegm; instead of the active and piercing salt and spirit that it would have afforded, when first expos'd to the fire, if the vessel had been carefully stoppt.



It will be very hard to prove, that there can no other body, or way be found, which will, as well as the fire, divide concretes into several homogeneous substances, that might, consequently, be call'd their elements, or principles, as well as those separated or produced by the fire. For since we have seen, that nature can successfully employ other instruments than the fire, to separate distinct substances from mixed bodies; how know we, but that she has made, or art may make, some substance a fit instrument to analyze them; or that some such method may not be found by human industry or chance; by means whereof compound bodies may be resolved into other substances, than fire divides them into. And why the products of such an analysis, may not as justly be called the component principles of the bodies that afford them, will not be easily shewn; especially since I shall hereafter make it evident, that the substances which chymists term salts, sulphurs, and mercurys of bodies, are not so pure and elementary as they presume. And this may, therefore, be more freely press'd upon the chymists, because neither the *Paracelsians*, nor the *Helmontians*, can reject it, without apparent injury to their masters. For *Helmont* more than once informs his reader, that both *Paracelsus* and himself possess'd the famous liquor alkahest; which, for its great power in resolving bodies irresoluble by vulgar fires, he seems to call *Ignis Gehenna*. To this liquor he ascribes, and that in great part upon his own experience, such wonders, that if we suppose them true, the alkahest seems a nobler and more desirable secret, than the philosopher's stone. Of this universal solvent he relates, that having digested with it for a competent time, a piece of oaken charcoal, it was thereby reduced into two new liquors, and different from each other in their colour and situation; and that the whole body of the coal was reduced into these liquors, both of them separable from his immortal menstruum; which remained as fit for such operations as before. And he, moreover, several times tells us, that by his powerful and unwearied agent, he could dissolve metals, marcasites, stones, vegetable and animal bodies, of what kind soever, even glass it self, and, in a word, all kinds of mixed bodies in the world, into their several similar substances, without any residue, or *Caput mortuum*. And, lastly, we may gather this further from his informations, that the homogeneous substances obtainable from compound bodies by his penetrating liquor, were often very different, both as to number and nature, from those into which the same bodies are usually divided by common fire; for in our common analysis of a mixed body, there remains a terrestrial, and very fixed substance, often associated with a salt as fixed; while our author declares, that by his way he could distil over all concretes, without any *Caput mortuum*; and, consequently, could make those parts of the concrete volatile, which, in the vulgar analysis, would have been fix'd. So that if our chymists will not reject the solemn and repeated

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testimony of a person, acknowledged one of the greatest in their way; they must not deny, that there is in nature another agent, able to analyze compound bodies with less violence, more genuinely and more universally than the fire. And, for my own part, tho' I always say, in case of any strange experiment; "he who hath seen it, hath more reason to believe it, than he who has not;" yet I have found *Helmont* so faithful a writer, even in several of his improbable experiments, that I think it somewhat harsh to give him the lie; especially in what he delivers upon his own proper trial. And having received some things from very credible eye-witnesses, and seen others my self, which argue so strongly, that a circulated salt, or a menstruum, may, by being extracted from compound bodies, leave them more unlock'd, than a wary naturalist would easily credit; I dare not confidently measure the power of nature, and of art, by that of the menstrua, and other instruments, which even eminent chymists employ, about the analyzing of bodies; nor deny, that a menstruum may, from a particular concrete, extract some apparently similar substance, different from any obtainable from the same body, by whatever degree of fire, or manner of its application. And I am the more unwilling peremptorily to deny, that there may be such openers of compound bodies; because among the experiments which make me speak thus cautiously, there were some in which it appear'd not that one of the substances, inseparable by common fires and menstrua, could retain any thing of the salt whereby the separation was made.

Some chymists, I know, will here reply, that they pretend not, by fire alone, to separate their hypostatical principles out of all compound bodies; it being sufficient that the fire divides them into such, tho' afterwards they employ other bodies to collect the similar parts of the compound; as 'tis known, that tho' they make use of water to collect the saline parts of ashes from the terrestrial, wherewith they are blended; yet it is the fire only that incinerates bodies, and reduces the fixed part of them into the salt and earth, whereof ashes consist. But I here only argue against those vulgar chymists, who themselves believe, and would persuade others, that the fire is not only an universal, but an adequate and sufficient instrument to analyze mix'd bodies with. For, as to their practice of extracting the fix'd salt out of ashes, by the affusion of water, 'tis obvious to alledge, that the water only assembles together the salt, which the fire had before divided from the earth; as a sieve does not further break the corn, but only bring together, into two distinct heaps, the flower, and the bran; whose corpuscles before lay promiscuously blended in the meal.

But tho' I allow the chymists, after the fire has done its office, the use of fair water to make their extractions with, in such cases wherein the water does not co-operate with the fire, to make the analysis; yet,  
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since I grant this, but upon supposition, that the water only washes off the saline particles which the fire alone has before extricated in the analyz'd body, it is not reasonable to extend this concession to other liquors that may add to what they dissolve. *Chymistry.*

And this premis'd, I observe, that many of the preceding instances, are such as the objection will not at all reach. For fire can no more, with the assistance of water, than without it, separate any of the three principles from gold, silver, mercury, &c.

Hence we may infer, that fire is not an universal analyzer of mix'd bodies; since of the metals and minerals, wherein chymists have most exercised themselves, there appear scarce any which they are able to analyze by fire, or from which they can unquestionably separate, even any one of their hypostatical principles.

It will also remain true, notwithstanding the objection, that there may be other ways than the usual analysis by fire, to separate from a compound body substances, as homogeneous as those which chymists scruple not to reckon among their three principles; that with convenient additions, such substances may be separated by the help of the fire, as cou'd not be so by the fire alone, witness the sulphur of antimony; and lastly, since it appears too, that the fire is but one of the instruments that must be employed in the resolution of bodies; whenever any menstruum or other addition is employed together with the fire, to obtain a sulphur or a salt from a body, we may well take the freedom to examine, whether or no, that menstruum hereby helps to separate the principle obtain'd by it, or whether there intervenes not a coalition of the parts of the body wrought upon, with those of the menstruum; whence the produced concrete may be judg'd to result from the union of both. And it will be farther allowable for us to consider, how far any substance, separated by the help of such addition, ought to pass for one of the three principles; since by one way of handling the same mix'd body, it may, according to the nature of the addition, and the method of working upon it, yield substances different from those it may afford by other additions, and a different method. Nay, they may, as we formerly said, differ from any of the substances into which a concrete is divisible by the fire without additions, tho', perhaps, those additions do not, as ingredients, enter the composition of the body obtain'd; but only diversify the operation of the fire upon the concrete, which, by the fire alone, may be divided into as great a number of different substances, as any of the chymists teach that of their elements to be.

But many *Peripatetics*, to prove fire the true analyzer of bodies, will plead, that it is the very definition of heat given by *Aristotle*, to be "that which assembles things of a similar, and disjoins those of an opposite nature." To which I answer, that this effect is far from being so essential to heat as 'tis generally imagin'd; for the true and genuine property of heat is rather to put in motion, and thereby dissociate the



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the parts of bodies, and subdivide them without regard to their being homogeneous or heterogeneous; as appears in the boiling of water, the distillation of quick-silver, or the exposing of bodies to the action of fire; where all that the fire can do is, to divide the body into very minute parts, which are of the same nature with one another, and with their wholes, as their reduction, by condensation, proves. And even when the fire seems most to associate such things as are similar, and disjoin such as are dissimilar, it produces that effect only by accident; for the fire does but dissolve, or rather shatter the frame or structure that kept the heterogeneous parts of bodies together, under one common form; upon which dissolution the component particles of the mix'd body being freed and set at liberty, naturally, and often without any operation of the fire, associate themselves each with its like, or rather take those places which their several degrees of gravity or levity, fixedness or volatility, assign them. Thus in the distillation of human blood, the fire first begins to dissolve the cement of the body, when the water being the most volatile and easie to be extracted, is either by the fiery atoms, or the agitation they are put into by the fire, first carried up till forsaken by that which rais'd it, its own weight sinks it down into the receiver; but all this while the other principles of the concrete remain unsever'd, and require a stronger degree of heat to make a separation of its more fix'd elements; and therefore the fire must be increased to carry over the volatile salt and the spirit, which, tho' supposed to be different principles, and tho' really of a different consistence, are yet of an almost equal volatility. After these comes over the oil, and leaves behind the earth and the alkali; which, being equally fix'd, the fire fails to sever them, notwithstanding the definition of the schools. And if into a red hot iron retort, you cast the matter to be distill'd, you may observe, that the predominant fire will carry up all the volatile elements, confusely, in one fume, which afterwards take their place in the receiver, either according to the degree of their respective gravity, or to the exigency of their several textures. Thus 'tis observable, that tho' oil, or liquid sulphur, be one of the elements, separated by the analysis, yet the heat which accidentally unites the particles of the other volatile principles, has not always the same operation on this; for there are several bodies which yield two kinds of oils, whereof the one sinks to the bottom of that spirit on which the other swims. And I have two oils, carefully made of the same parcel of human blood, which not only differ extremely in colour, but swim upon one another, without mixing; and if, by agitation, confounded, will, of themselves, separate again.

And that the fire often divides bodies, upon this account, that some of their parts are more fix'd, and others more volatile, how far soever either of the two may be from a pure, elementary nature, is obvious enough, in the burning of wood, which the fire dissipates into smoke and ashes; for not only the latter of these is confessedly made up of

two

two such different bodies, as earth and salt, but the former being condens'd into foot, discovers it self to contain salt, oil, spirit and earth, with some portion of phlegm; all which being almost equally volatile, in that degree of fire which forces them up, are carried away together; but may afterwards be separated by other degrees of fire, whose orderly gradation allows the difference of their volatility to discover it self\*. Besides, if two different bodies, united into one mass, be both sufficiently fix'd, the fire, finding no parts volatile enough to be carried up, makes no separation at all; as appears by a mixture of melted silver and gold, whose component metals may be easily separated by *Aqua fortis*, or *Aqua regia*; but in the fire alone, tho' vehement, they remain unsever'd; that only dividing the body into smaller particles, in which either the little nimble atoms of fire, or its brisk and numberless strokes upon the vessels, hinder rest and continuity, without producing any elementary principles. Moreover, the fire sometimes does not separate so much as unite bodies of a different nature; provided they be near allied in fixedness, and have in the figure of their parts, an aptness to coalition; as we see in making many plasters, ointments, &c. and in such metalline mixtures, as that made by melting together two parts of clean brass, with one of pure copper; of which, some ingenious tradesmen, cast curious patterns for gold and silver works. Sometimes the bodies mix'd by the fire, are different enough, as to fixedness and volatility, yet so combined by the first operation of the heat, that it only afterwards serves to pulverize them. This is visible in the preparation of *Mercurius dulcis*; where the saline particles of the vitriol, sea-salt, or nitre, employ'd to make the sublimate, so unite themselves with the mercurial particles, made use of first to prepare the sublimate, and then to dulcify it, that the saline and metalline parts rise together in many successive sublimations, as if they all made but one body; and sometimes too, the fire combines the different elements of a body so firmly, that nature her self, very seldom makes less dissoluble unions. For the fire meeting with some bodies exceedingly, and almost equally fix'd, instead of mak-

\* M. Homberg has been very curious to obtain, if possible, the true principles of plants by chymical analysis. The result of his numerous experiments, is, that salt, oil, water, and earth, are constantly found in all vegetable productions, in what manner soever their analysis be made; that, according to the difference in the operation, these principles are more or less volatile, or fixt; that their different volatility, and fixedness, may proceed as well from the fermentation of the body, as the force of the fire; that a strong fire, by driving over all the principles at once,

confounds the analysis; that the fire always evaporates some parts of the subject, which can never be recover'd; that to obtain these principles, as pure as possible, only fermentation and a gentle fire should be employ'd; and lastly, that the constitution and virtue of every plant, consisting in the exact proportion, arrangement, and texture of its principles, the fire either destroys what sets the difference between two very dissimilar plants, or, the same vegetable, once analyzed, can scarce be perfectly restored. See *Hist. de l'Academ. R. A.* 1701. p. 86. and *Memoirs*, p. 148.

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making a separation, causes so strict an union, that it self alone is unable to dissolve it; as when an alkaline salt, and the terrestrial residue of the ashes, are incorporated with pure sand, and by vitrification, made one permanent body, the greenish sort of glass, that eludes the greatest violence of the fire. I have some pieces of glass, which I saw flow down from an earthen crucible, expos'd for a good while with silver in it, to a very vehement fire. And those, who deal much in the fusion of metals, inform me, that the melting of a great part of a crucible, is no great wonder in their furnaces. I remember I have observ'd too, in the melting of great quantities of iron out of ore, by the help of charcoal, that by the prodigious vehemence of the fire, part of the materials expos'd, was, instead of being analyz'd, fused, and turn'd into a dark, solid, and very ponderous glass; and this happens in such quantities, that in some places, I have seen, the very high ways, near some iron-works, mended with such lumps of glass. I have also observ'd, that some kind of fire-stone it self, having been employ'd in furnaces, where it was expos'd to very strong, and lasting fires, has had all its fix'd parts so wrought on thereby, as to be perfectly vitrified; as I have try'd, by forcing from it pretty large pieces of perfect, transparent glass. And to shew, that the preceding definition of heat, is not countenanced by that of its contrary quality cold, which is said to associate things homogeneous and heterogeneous; I must observe, that neither is this definition unquestionable: for the union of heterogeneous bodies, suppos'd to be the genuine production of cold, is not perform'd by every degree of that quality. We see, for instance, that when the urine of healthy men, has been suffer'd to stand for a while, the cold makes a separation of the thinner part from the grosser, which subsides to the bottom, and grows opaque there; whereas, if the urinal be made warm, those parts readily mix again, and the whole liquor becomes transparent as before. And when by glaciation, wood, straw, dust, water, &c. are suppos'd to be united into one lump of ice, the cold does not cause any real union of these bodies, but only hardening the aqueous parts of the liquor into ice, the other bodies being accidentally present in that liquor, are frozen up in it, not really incorporated. And accordingly, if we expose a heap of money, consisting of gold, silver, and copper coins, or any other bodies of different natures, which are incapable of congelation, to ever so intense a degree of cold; we find not they are at all so much as compacted thereby, much less united together: and even in liquors themselves, we find phenomena, which induce us to question the definition we are examining. If the authority of *Paracelsus* were a sufficient proof in matters of this nature, I might here insist on that process of his, whereby he teaches, that the essence of wine may be struck to the center, and sever'd from the phlegm and ignoble part, by the assistance of congelation.

But



But I dare not lay much stress upon this process, because I have found, that if it were true, it would be but seldom practicable in this country upon the best wine; for in our sharpest winters, I cou'd never tolerably freeze a thin vial of canary; and even with snow and salt, but little deeper than the surface: and I suppose it is not every degree of cold, capable of congealing liquors, which will make such an analysis of them by separating their aqueous and spirituous parts; for I have, sometimes, severally frozen red wine, urine, and milk, but could not observe any separation. And the *Dutch*, who winter'd in *Nova Zembla*, tho' they relate, that there was a separation of parts made in their frozen beer, about the middle of *November*; yet of the freezing of their sack in *December* following, they only say, "it was frozen very hard; so that when every man was to have his part, we were forc'd to melt it in the fire." In which words they imply, not that their sack was divided into different substances, as their beer had been. But notwithstanding this, I am of opinion, that even cold may, sometimes, unite similar, and separate dissimilar substances. I once purposely caus'd a plant, abounding with sulphureous and spirituous parts, to be boiled in fair water; and having expos'd the decoction to a sharp north wind, in a very frosty night, I observ'd, that the more aqueous parts of it were, by the next morning, turn'd into ice; towards the innermost part of which, the more agile and spirituous portions, as I then conjectured, having retreated, they there preserv'd themselves unfrozen, in the form of a high color'd liquor; the aqueous and spirituous parts having been so slightly blended in the decoction, that they were easily separable by such a degree of cold, as would not have divorc'd the parts of urine or wine, which, by fermentation or digestion, are more intimately associated with each other. But the *Dutch*, in *Nova Zembla*, found a barrel of beer so frozen, that the spirituous part appear'd separated from the yeast, whilst some on the outside of the vessel was frozen as hard as glue; the other, which was converted to ice, being almost insipid.

And having once purposely try'd to freeze some beer, that was moderately strong, in glass vessels with snow and salt, I observ'd, that there came out of the neck a certain thick substance, which, it seems, was much better able than the rest of the liquor, that I found turn'd into ice, to resist the frost; and which, by its colour and consistence, seem'd manifestly to be yeast. This, I confess, somewhat surpriz'd me; because I could not discern by the tast, or find by enquiry, that the beer was too new, to be very fit for drinking. I might confirm the *Dutchmens* relation, by what lately happen'd to a friend of mine, who complain'd to me, that having brew'd some ale in *Holland*, the cold of the winter there, froze it into ice, and left only a small proportion of a very strong and spirituous liquor.

## S E C T. II.

*That some things obtained from a body by fire, were not its proper ingredients.*

IT is not so certain, as both chymists and *Aristotelians* imagine, that every seemingly similar, or distinct substance, separated from a body, by the help of the fire, was pre-existent in that substance, as a principle. I do not mean, that any thing is separable from a body by fire, that was not materially pre-existent in it; for it far exceeds the power of meer natural agents, to produce a-new, so much as a single atom of matter, which they can only modify and alter, not create.

Nor do I peremptorily deny, that some things obtain'd by the fire from a mix'd body, may have been more than barely materially pre-existent in it; since there are concretes, which before being expos'd to the fire, shew they abound some with salt, and others with sulphur. It will serve the present purpose, if it appear, that several things, obtain'd from a mix'd body, expos'd to the fire, were not its ingredients before; for then it will be rational to expect, that chymists may deceive themselves and others, in concluding, resolutely and universally, those substances to be the elementary ingredients of bodies, barely separated by the fire, of which it may yet be question'd whether they exist or no; at least till some other argument than that drawn from the analysis, be produced to resolve the doubt.

I say then, it may, without absurdity, be doubted, whether the different substances obtainable from a concrete dissipated by the fire, were existent in it, in that form (at least, as to their minute parts,) wherein we find them after the analysis, so that the fire only disjoin'd and extricated the corpuscles of one principle from those of another, wherewith they before were blended.

*That all compound bodies seem to differ only in some mechanical properties.*

Upon this supposition, I shall endeavour to shew, first, that such substances, as chymists call principles, may be produced *de novo*; and secondly, to make it probable, that by the fire we may actually obtain from some mix'd bodies such substances, as were not, in the sense deliver'd, pre-existent in them.

Now, if it be true, as 'tis probable, that compound bodies differ from one another, in nothing but the various textures, resulting from the magnitude, shape, motion, and arrangement of their small parts, it will not be irrational to conceive, that one and the same parcel of universal matter, may, by various alterations and contextures, be brought to deserve the name sometimes of a sulphureous, and sometimes of a terrestrial or aqueous body.

*Argued from growth of plants.*

About the beginning of *May*, I caus'd my gardener to dig out a convenient quantity of good earth, to dry it well in an oven, to weigh it, to put it in an earthen pot, almost level with the surface of

of the ground, and to set in it a particular seed of squash, or the *Chymistry.* Indian kind of pompion, of sudden growth; this seed I order'd him to water only with rain or spring-water. 'Twas delightful to behold how fast this grew, tho' unseasonably sown; but the winter coming on, hinder'd it from attaining any thing of its due magnitude; which made me order it to be taken up about the middle of *October*. This being carefully done, it weigh'd with the stalk and leaves two pounds and three quarters; then the earth being baked as formerly, its weight was found the same as at first; and being set into the oven twice more, and weigh'd again, it shrunk little or nothing.

But I must not conceal, that in another experiment of this kind, the earth seem'd to have been much more waisted; yet here, as well as in the former trial, it appeared, that the main body of the plant, consisted of transmuted water. And I might add, that I caus'd the former experiment, with large pompions, to be repeated with so good success, that it not only much surpass'd any I made before, but seem'd strangely to conclude what I am pleading for. The like experiments may be as conveniently try'd with the seeds of any plant, whose growth is hasty, and its size large. If tobacco will thrive in these cold climates, in earth unmanured, it would not be amiss to make a trial with it; for it is an annual plant, that rises where it prospers, sometimes as high as a tall man; and I have had leaves of it in my garden, near a foot and a half broad. But the next time I make this experiment, it shall be with several seeds of the same sort, in the same pot of earth; that so the event may be the more conspicuous. But because every body has not conveniency of time and place, for this experiment, I made some shorter, and more expeditious trials in my chamber. I took a top of spear-mint, about an inch long, and put it into a vial full of spring-water, so that the upper part of the mint reach'd above the neck of the glass, while the lower was immers'd in the water; within a few days, this mint began to shoot out roots into the water, to display its leaves, and to aspire upwards; and in a short time, it had numerous roots and leaves, and these very strong and fragrant of the odour of the mint; but the heat of my chamber, as I suppose, kill'd the plant, when it was grown to have a pretty thick stalk; which with the various and ramified roots it shot into the water, as if it had been earth, presented a pleasant spectacle. The like I have try'd with sweet marjoram, and found the experiment succeed also, tho' somewhat more slowly with baulm and penniroyal, &c. And one of these vegetables, nourish'd only by water, having obtain'd a competent growth, I caus'd to be distill'd in a small retort; and thereby obtain'd some phlegm, a little empyreumatical spirit, a small quantity of adust oil, and a *Caput mortuum*, which appearing to be a coal, I concluded it to consist of salt and earth; but the quantity of it was so small, that I forbore to calcine it. The water used to nourish this plant,



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was not shifted, nor renewed; and I chose spring-water, rather than rain-water, because the latter is more discernably a kind of *marasma*, which, tho' free from grosser mixtures, seems to contain in it, besides the steams of several bodies wandering in the air, a certain spirituous substance, which may be extracted out of it; and is by some mistaken for the spirit of the world embodied.

But *Helmont* avers, that he took 200 pounds of earth, dry'd in an oven; and having put it into an earthen vessel, and moisten'd it with rain-water, planted in it the trunk of a willow tree, of five pound weight; this he water'd, as occasion requir'd, with rain, or with distill'd water; and to keep the adjacent earth from getting into the vessel, he employed a perforated plate of iron. After five years he took out the tree, weigh'd it, and computing the leaves that fell in four autumns, he found it to weigh 169 pounds, and about three ounces. And having again dry'd the earth it grew in, he found it to want of its former weight of 200 pounds, only about two ounces; so that 164 pounds of the roots, wood, and bark, which constituted the tree, seem to have sprung from the water. And, doubtless, if *Helmont* had made any analysis of this plant, as I did of one of my plants, fed only with fair water, it would have afforded him the like distinct substances, as another vegetable of the same kind.

And water  
being the prin-  
ciple of all  
things.

*Helmont*, we know too, asserts, that all mix'd bodies spring from one element; and that vegetables, animals, marcasites, stones, metals, &c. are materially but simple water, disguiz'd into these various forms by the plastic virtue of their seeds; and his principal reasons for it seem to be these. 1. The ultimate reduction of mixed bodies into insipid water. 2. The vicissitude of the supposed elements. And, 3. The production of perfectly mix'd bodies out of simple water. And, first, he affirms, that his alkahest adequately resolves plants, animals, and minerals, into one liquor, or more, according to their several internal differences of parts; and that the alkahest being abstracted from these liquors, in the same weight and with virtue, as when it dissolv'd them, the liquors may, by frequent cohobations from chalk, or some other proper matter, be totally depriv'd of their seminal endowments, and return at last to their first matter, insipid water. Other ways he also proposes, to divest some particular bodies of their borrowed shapes, and make them return to their first simplicity. The second topic whence *Helmont* argues water to be the material cause of mixed bodies, is, that the other supposed elements may be transmuted into one another. But the experiments he produces on this occasion are so difficult to be made, and judg'd of, that I shall not insist upon them. Besides, if they were granted to be true, his inference from them is somewhat disputable; and as our author in his first argument, endeavours to prove water the sole element of mix'd bodies, by their ultimate resolution, when by his alkahest, or some other conquering agent, the seeds have been worn out, or destroyed,  
which

which disguised them; so in his third argument, he attempts to shew the same by the constitution of bodies; which he asserts to be nothing but water subdued by seminal virtues. Of this he gives various instances, as to plants and animals; but several of them being difficult, either to be made or understood, and others of them liable to different exceptions; the instance of the willow-tree seems the most proper to insist on. However, this opinion of his is no new one; tho' the arguments for it may, in great measure, be his own. The doctrine is ascribed to *Thales*, to *Homer*, to *Hesiod*, to *Moses*, and to the *Phenicians*, who taught, that the earth was made of water; and from them, 'tis supposed that *Thales* took it.

And tho' *Helmont* produces no instance of any mineral body, and scarce of any animal, generated of water; yet a *French* chymist, *M. de Rochas*, affords us an experiment, which, if it succeeded as he delivers it, is very remarkable. "Having," says he, "found surprizing things from the natural operation of water, I was willing to know what might be done with it by art. I therefore took water, which, I knew, was mixed with no other thing than the spirit of life; and by a heat artificial, continual, and proportionate, I prepared and disposed it by the graduations of coagulation, congelation, and fixation, till it was turned into earth, which produced animals, vegetables, and minerals. I say not what animals, vegetables, and minerals, for that is reserved for another occasion; but the animals moved of themselves, eat, &c. and by the anatomy I made of them, I found them compos'd of much sulphur, little mercury, and less salt. The minerals began to grow and increase, by converting into their own nature one part of the earth thereto disposed; they were solid and heavy. And by this truly demonstrative science, chymistry, I found that they were composed of much salt, little sulphur, and less mercury."

But I have some suspicions concerning this strange relation, which make me unwilling to declare an opinion of it; unless I were satisfied in several material circumstances, which our author has left unmentioned: tho' as for the generation of living creatures, both vegetable and sensitive, it need not seem incredible; since we find, that our common water, which is often impregnated with variety of seminal principles, long kept in a quiet place, will putrefie; and then too, perhaps, produce moss and little worms, or other insects, according to the nature of the seeds that were lurking in it. And as *Helmont* gives no instance of the production of minerals out of water; so the principal argument that he employs, to prove that they and other bodies may be resolv'd into water, is drawn from the operations of his alkahest, and, consequently, cannot be satisfactorily examined by us.

'Tis, however, surprizing to observe, how great a share of water goes to make up several bodies, whose forms promise nothing near so much. Eels, by distillation, yielded me some oil, spirit, and volatile salt, besides the *Caput mortuum*; yet all these were so disproportionate to the phlegm, that they seemed to have been nothing but that

coa-

*Chymistry.* coagulated; which, likewise, strangely abounds in vipers, tho' they are esteemed very hot in operation, and will, in a convenient air, survive for some days the loss of their heads and hearts. Human blood it self, as spirituous and as elaborate a liquor as 'tis reputed, so abounds in phlegm, that distilling some of it, on purpose to try the experiment; out of about seven ounces and a half, we drew near six ounces of phlegm, before any of the more operative principles began to rise. And, to satisfy my self that some of these animal phlegms were sufficiently destitute of spirit, to deserve their name; I was not content to taste them only, but poured on them acid liquors, to try if they contained any volatile salt or spirit; which would probably have discovered it self, by making an ebullition with the liquor thus employed. And tho' corrosive spirits seem to be nothing else but fluid salts, yet they also abound in water; which may be observed, by entangling, and so fixing their saline part, as to make them corrode some proper body; or else if it be mortified with a contrary salt, as I have very manifestly observed, in making a medicine somewhat like *Helmont's Balsamus Samech*, with distill'd vinegar, instead of spirit of wine, wherewith he prepares it; for of that acid spirit, the salt of tartar, from which it is distill'd, will, by mortifying and retaining the acid salt, turn into worthless phlegm, near twenty times its weight, before it be so fully impregnated, as to rob no more distilled vinegar of its salt. And tho' spirit of wine, exquisitely rectified, seems of all liquors to be the most free from water; yet even this is by *Helmont*, in case what he relates is true, with probability, affirmed to be materially water, under a sulphureous disguise; for, according to him, in making that excellent medicine *Paracelsus's Balsamus Samech*, (which is nothing but *Sal tartari* dulcified, by distilling spirit of wine from it, till the salt be sufficiently saturated with its sulphur; and till it suffers the liquor to be drawn off as strong as it was poured on;) when the salt of tartar, from which it is distilled, hath retained, or deprived it of the sulphureous parts of the spirit of wine; the rest, which is incomparably the greater part of the liquor, will turn to phlegm. But I have not as yet sufficiently tried the thing my self: however, something of experiment keeps me from thinking it absurd; tho' I in vain try'd it with ordinary salt of tartar: for *Helmont* not only often relates it, and draws consequences from it, but a person noted for his veracity, and skill in chymistry, affirm'd to me, that by preparing the salt and spirit, in a way suitable to my principles, he had made the experiment succeed very well; without adding any thing to the salt and spirit.

I have indeed, sometimes, wondered to see how much phlegm may be obtained from bodies by fire. But supposing the alkalest could reduce all bodies into water; yet whether the water, because insipid, must be elementary, may be doubted: for I remember the candid *Petrus Laurembergius* affirms, he saw an insipid menstruum, that was a powerful dissolvent, even of gold. And the water which may be drawn from



from quick-silver, without addition, tho' it be almost tasteless, appears of a different nature from simple water; especially if appropriated minerals be therein digested. And farther, I see no necessity to conceive, that the water mentioned by *Moses*, on which the spirit is said to have brooded, as the universal matter, was simple and elementary water; since tho' we shou'd suppose it to have been an agitated congeries, consisting of a great variety of seminal principles, and of other corpuscles fit to be subdued and fashioned by them; it might yet be a body fluid, like water, in case the corpuscles it was made up of were, by their creator, made small enough, and put into such an actual motion as might make them roll and glide over one another. And as we now say the sea consists of water, notwithstanding the saline, terrestrial, and other bodies mix'd with it; such a liquor as the former may well be call'd water; because that was the greatest of unknown bodies whereto it was like. But that a body may be fluid enough to appear a liquor, and yet contain corpuscles of a very different nature, appears from exposing a quantity of vitriol in a strong vessel to a competent fire; for tho' it contains aqueous, earthy, saline, sulphureous, and metalline parts; yet the whole mass will at first be fluid, and boil like water.

But whether or no we conclude all things to have been generated of water, 'tis manifest, from what I have try'd, as to the growth of vegetables fed with water, that salt, spirit, earth, and even oil, may be produced out of water; and consequently, that a chymical principle as well as a *Peripatetic* element, may, in some cases, be generated anew, or obtain'd from such a parcel of matter as was not before endow'd with the form of such a principle or element.

I shall next endeavour to shew, that the operation of the fire, sometimes, not only actually divides mix'd bodies into small parts, but compounds those parts after a new manner; whence there may possibly result, as well saline and sulphureous substances, as those of different textures. And, perhaps, it will assist us in our inquiry into the effects of the operations of the fire upon other bodies, to consider a little what it does to those mixtures, which being the productions of art, we best know what enters their composition. Now, tho' sope is made up of oil or grease, salt and water, well incorporated together; yet if you expose the mass they constitute, to a gradual fire, in a retort, you will indeed make a separation, tho' not of the same substances that were united into sope; but of others of a different, and not an elementary nature; and especially of an oil very sharp, fetid, and remote in quality from that employ'd to make the sope: so if you mix sal-armoniac, in a due proportion, with quick-lime, and distil them by degrees of fire, you shall not divide the sal-armoniac from the quick-lime; tho' the one be a volatile, and the other a fixed substance; but that which ascends will be a spirit much more fugitive, piercing, and fetid, than sal-armoniac; and there will remain with the quick-lime almost

The fire also compounds the parts of bodies after a new manner.

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most all the sea-salt that concurr'd to compose the sal-armoniac. And how well the sea-salt was united to the lime, appears from hence, that I have, by making the fire at length very vehement, caus'd both the ingredients to melt, in the retort, into one mass, apt to grow moist in a damp air. If it be here objected, that these instances are taken from factitious concretes, which are more compounded than natural ones; I reply, it will be difficult to prove, that nature her self does not mix together such bodies as are already compounded of elementary or more simple ones. Thus vitriol, for instance, tho' I have sometimes taken it out of the mineral earths, where nature had, without the assistance of art, prepared it, is really a mix'd body, consisting of a terrestrial substance of a metal, and also of at least one saline body of a peculiar, and not elementary nature. And we see, also, in animals, that their blood may be compos'd of several very different mix'd bodies; since many sea-fowl tast rank of the fish on which they ordinarily feed. And *Hippocrates* observes, that a child may be purg'd by the milk of the nurse, who has taken elaterium; which argues, that the purging corpuscles of the medicament concur to make up the milk of the nurse. And from many vegetables there may, without any addition, be obtain'd glass; a body surely not pre-existent in them, but produced by the fire. I shall only add, that by a certain artificial way of managing quick-silver, I can, without addition, separate from it a fourth part of a clear liquor, which, with an ordinary *Peripatetic*, wou'd pass for water, and which a vulgar chymist wou'd take for phlegm; and this, for ought I have yet seen or heard, is not reducible into mercury again, and consequently, is more than a disguise of it. Now, besides that several chymists will not allow mercury to have any considerable quantity of either of the ignoble ingredients, earth and water; the great ponderousness of quick-silver makes it unlikely, that it can contain so much water as may thus be obtain'd from it; since mercury weighs fourteen times more than water of the same bulk. And two friends of mine, the one a physician, and the other a mathematician, both of them persons of unsuspected credit, have solemnly assured me, that, after many trials they made to reduce mercury into water, in order to a philosophical work upon gold; they once, by several cohobations, reduced a pound of quick-silver into almost a pound of water; and this without the addition of any other substance, but only by urging the mercury with a fire, skilfully managed. Hence it sufficiently appears, that the fire may sometimes as well alter bodies as divide them; and that by its means, we may obtain from a mix'd body what did not pre-exist therein. And how are we sure that phlegm is barely separated, not produced, in other bodies by the action of fire; for, many other mix'd bodies are of a much less constant, and more alterable nature, than mercury appears to be? If we believe *Helmont's* relations, the *tria prima*, or three chymical principles, are neither ingenerable, nor incorruptible substances; since by his

his alkahest, some of them may be produced of bodies that were before of another denomination, and all by the same powerful menstruum, be reduced into insipid water. *Chymistry.*

But here may occur a scruple about the nature of mixture. *Aristotle*, we know, declares it to be such a mutual penetration, and perfect union of the elements, that there is no portion of the mix'd body, how minute soever, which does not contain all and every of the four elements; or in which, all the elements are not. And I remember, he reprehends the mixture taught by the ancients, for too slight or gross, as that wherein the elements were only blended, not united: the ancients, however, tho' they did not all agree what kind of bodies were mix'd; yet they almost unanimously held, that in a compounded body, tho' the *Miscibilia* were associated in such small parts, and with so much exactness, that there was no sensible particle of the mass, but seem'd of the same nature with the rest, and with the whole; but as to the insensible parcels of matter, whereof the *Miscibilia* consisted, they were suppos'd to retain each of them its own nature, being but by apposition united with the rest, into one body. So that tho', by virtue of this composition, the mix'd bodies, perhaps, obtain'd several new qualities; still the ingredients that compounded it, retaining their own nature, were, by the destruction of the composition, separable from each other; the minute parts, disengaged from those of a different nature, and associated with those of their own sort, returning to fire, earth, or water, as they were before they chanc'd to be ingredients of that composition. Thus in a piece of cloth, made of white and black threads interwoven, wherein, tho' the whole appear neither white nor black, but grey; yet each of the white and black threads, that compose it, remains what it was before, if they were pull'd asunder, and sorted, each colour by its self. *The nature of mixture considered.*

*Aristotle* tells us, that if a drop of wine be put into ten thousand measures of water, the wine being overpower'd by so vast a quantity of water, will be turn'd into it. But if this doctrine were true, one might hope, by melting a mass of gold and silver, and by but casting into it lead or antimony, grain after grain, we might, at pleasure, within a reasonable compass of time, turn what quantity we desired of the ignoble, into the noble metals. Yet in that operation, which the refiners call quartation, and employ to purify gold, altho' three parts of silver be so exquisitely mix'd, by fusion, with a fourth part of gold, that the resulting mass acquires several new qualities, by virtue of the composition; and that there is scarce any sensible part of it which is not compos'd of both the metals; yet if this mixture be cast into *Aqua fortis*, the silver will be dissolved therein, and the gold, like a dark or black powder, will fall to the bottom; and either body may be again reduced into such a metal, as it was before; which shews, that each retain'd its nature, notwithstanding its being mix'd per



*Chymistry.* *minima*, with the other. We likewise see, that tho' one part of pure silver, be mixed with ten parts, or more, of lead; yet the fire will, upon the cupel, easily and perfectly separate them again. And not only in chymical analyses, a separation is made of the elementary ingredients, but some mixed bodies afford a much greater quantity of one particular principle than of another; as turpentine and amber yield much more oil and sulphur, than water; whilst wine, which is confess'd to be a perfectly mix'd body, affords but a little inflammable spirit or sulphur, and not much more earth; but a vast proportion of phlegm, or water; which could not be, if, as the *Peripatetics* suppose, every minute particle were of the same nature with the whole; and, consequently, contained earth and water, air and fire.

But not to consider those improper mixtures, wherein homogeneous bodies are join'd, as when water is mix'd with water; proper mixtures seem, in the general, to be but an intimate union of any two or more bodies, of different denominations; as when ashes and sand are fused into glass, or antimony and iron into *Regulus Martis*; when wine is shook with water, or sugar dissolv'd in the same. Now in this general notion of mixture, it does not appear, that the ingredients do, in their small parts, so retain their nature, and remain distinct in the compound, that they may thence, by the fire, be again taken asunder. For tho', perhaps, in some mixtures of certain permanent bodies, this recovery of the same ingredients may be made; yet I am not convinced, that it will generally hold, or that it is deducible from chymical experiments, and the true notion of mixture. But bodies, I presume, may be mixed, and that very durably, tho' they are not elementary, nor have been resolved into elements, or principles, in order to it; as is evident in the *Regulus* of fused antimony and iron; and in gold coin, which lasts for many ages, whilst the gold is generally alloy'd by the mixture of a quantity of silver, or copper, or of both. And there being but one universal matter of all things, the portions of it seem to differ from one another, only in certain qualities, or accidents; upon whose account the corporeal substance they belong to, receives its denomination, and is refer'd to some particular sort of bodies; so that if it be deprived of those qualities, tho' it ceases not to be a body, yet it ceases from being that kind of body, as a plant, or an animal, a red, or a green, a sweet, or a sour substance. It also frequently happens, that the small parts of bodies cohere together but by immediate contact and rest; whilst there are few bodies, whose minute parts stick so close together, but that it is possible to meet with some other body, whose small parts may get between them, and so disjoin them; or may be fitted to cohere more strongly with some of them, than those do with the rest; or, at least, may be combined so closely therewith, that neither the fire, nor the other usual instruments of chymical analyses, will separate them. These things considered, I cannot

cannot peremptorily deny, that there may be some small masses, wherein the particles are so minute, and the coherence so strict, or both, that when bodies of different denominations, and consisting of such durable masses, happen to be mingled; tho' the compound body made up of them, may be very different from either of the ingredients, yet each of the little clusters may so retain its own nature, as to be again separable to what it was before. Thus when gold and silver are melted together in a due proportion, *Aqua fortis* will dissolve the silver, and leave the gold untouch'd; by which means both the metals may be recover'd from the mixed mass. There are other clusters also, wherein the particles stick not so close together, but they may meet with corpuscles of another denomination, dispos'd to be more closely united with some of them, than they were among themselves; and in such case, two corpuscles thus combining, losing that shape, size, motion, or other accident, upon whose account they exhibited such a determinate quality, or nature; each of them really ceases to be a corpuscle of the same denomination it was before; and from the coalition of these, there may result a new body, as really one as either of the corpuscles, before they were confounded; for this concretion is really endowed with its own distinct qualities, and can no more, by the fire, nor any other known way of analysis, be divided again into the corpuscles, that at first concurr'd to make it, than either of them could, by the same means, be subdivided into other particles. Thus, by crystallizing a solution of copper in *Aqua fortis*, or spirit of nitre, you may obtain a good vitriol; which, tho', by virtue of the composition, it has manifestly several qualities not to be met with in either of the ingredients; yet it seems, that the nitrous spirits may, in this compound mass, retain their former nature: for having distilled this vitriol, there came over plenty of red fumes; which, by that colour, by their peculiar ill scent, and by their sourness, manifested themselves to be nitrous spirits: and that the remaining calx continued copper, will be easily believed. But if you dissolve minium, which is but lead powder'd by the fire, in good spirit of vinegar, and crystallize the solution; you shall not only have a saccharine salt, exceedingly different from both its ingredients; but the union of some parts of the menstruum, with others of the metal, is so strict, that the spirit of vinegar seems to be destroyed in that capacity; since the saline corpuscles have quite lost their acidity: nor can such acid parts as were put to the minium, be separated, by any known way, from the *Saccharum Saturni*, resulting from them both; for there is no sourness at all, but an admirable sweetness to be tasted in the concretion. And not only spirit of wine, which, otherwise, will immediately hiss when mingled with strong spirit of vinegar, had no such effect when poured upon *Saccharum Saturni*; wherein yet the acid salt of vinegar, did it survive, may seem to be concentrated; but upon the distillation of *Saccharum*

*Chymistry.*

*Saturni* by it self, I found, indeed, a liquor very piercing, but not at all acid; and different as well in smell, and other qualities, as in taste, from the spirit of vinegar; which, likewise, seem'd to have le't some of its parts very firmly united to the *Caput mortuum*: and this, tho' of the nature of lead, was in smell, colour, &c. different from minium. Thus, also, tho' two powders, the one blue, and the other yellow, may appear a green mixture, whilst neither of them loses its own colour, as a good microscope has sometimes informed me; yet having mixed minium and sal-armoniac in a due proportion, and expos'd them in a glass vessel to the fire, the whole mass became white, and the red corpuscles were destroyed; for tho' the calcin'd lead was separable from the salt, yet it did not part from it in the form of a red powder, such as the minium was, when put to the sal-armoniac. I leave it, also, to be considered, whether in blood, and several other bodies, it be probable, that each of the corpuscles concurring to make up the compound, always retains its own nature therein; so that chymists may extricate each sort of them from all the others, where-with it contributed to compose a body of one denomination.

And since the major part of chymists allow, what those they call philosophers affirm of their stone; they may please to consider, that tho' when common gold and lead are mixed together, the lead may be fever'd almost unalter'd from the gold; yet if, instead of gold, a little of the red elixir be mixed with the lead, their union will be so indissoluble in the perfect gold produced thereby, that there is no known, nor, perhaps, possible way of separating the diffus'd elixir from the fix'd lead; but they both constitute a most permanent body, wherein the lead seems quite to have lost its properties; and to have been rather transmuted by the elixir, than associated with it. Hence it seems not always necessary, that the bodies intimately mixed, should each retain its own nature; so as, when the mass it self is dissipat'd by the fire, to be more disposed to appear again in its pristine form, than in a new one; which it may have acquired by a stricter association of its parts, with those of some of the other ingredients of the composition, than with one another.

If it be objected, that unless the hypothesis I oppose, be admitted, in such cases as we have mentioned, there would not be an union, but a destruction of the mix'd bodies; which seems all one as to say, that of such bodies there is no mixture at all: I answer, that tho' the mix'd substances remain, whilst only their accidents are destroyed; and tho' we may call them ingredients, because they were distinct bodies before they were put together; yet they are afterwards so confounded, that I shall rather call them concretions, or resulting bodies, than mix'd ones.

If it be also said, that this notion of mixture, tho' it may be allow'd when bodies already compounded are put to be mix'd; yet it is not applicable to those mixtures, that are immediately made of the elements,



ments, or principles themselves: I reply, that I here consider the nature of mixture, somewhat more generally than the chymists; who yet cannot deny, that there often are mixtures, and those very durable ones, made of bodies not elementary. And farther; tho' it may be probably pretended, that in those mixtures, made immediately of the bodies called principles or elements, the mix'd ingredients may better retain their own nature in the compound mass, and be more easily separated from thence; yet besides that it may be doubted; whether there are any such primary bodies, I see not why the reason I alludg'd, of the destructibility of the ingredients of bodies in general, may not, sometimes, be applicable to salt, sulphur, or mercury; till it be shewn upon what account we are to own them priviledg'd.

But to return from whence this consideration of mixture has carry'd us. We have seen, by the different substances obtained from a plant, &c. nourished only with water, that it was not necessary nature should always compound a body originally, of all such different bodies, as the fire could afterwards make it afford. But this is not all that may be collected from those experiments. There seems, also, something deducible from them, that subverts another foundation of the chymical doctrine. For since out of fair water alone, not only spirit, but salt, oil, and earth, may be produced, it follows, that salt and sulphur are not primogeneal bodies and principles; since they are every day made out of plain water, by the texture which the seed, or seminal principle of plants, gives it. And this would not, perhaps, seem so strange, did we not overlook the obvious and familiar operations of nature; for if we consider what slight qualities they are that serve to denominate one of the *tria prima*; we shall find that nature frequently produces as great alterations in several parcels of matter. To be readily dissoluble in water, is enough to make a body pass for a salt; yet I see not why, from a new arrangement and disposition of the component particles, it should be much harder for nature to compose a body dissoluble in water, of a portion of matter that was not so before; than of the liquid substance of an egg, which will easily mix with water, to produce, by the bare warmth of the brooding hen, membranes, feathers, tendons, &c. not dissoluble in water. Nor is the hardness and brittleness of salt, more difficult for nature to introduce into such a yielding body as water, than it is for her to form the bones of a chick, out of the tender substance of the liquors of an egg. But I easily foresee it will be alledg'd, that the former examples are all taken from plants and animals, wherein the matter is fashioned by the plastic power of the seed, or something analogous thereto; whereas the fire does not act like any of the seminal principles, but destroys them all, when they come within its reach. To this I need only say, that whether it be a seminal principle, or any other, which fashions the matter, after those various manners I have mention'd; 'tis evident, that either by the plastic power.

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power alone, or that and heat together, or by some other cause, capable of giving a texture to the matter; it is yet possible that it may be a-new contriv'd into such bodies.

And thus much, I presume, will suffice to shew, that a considering man may very well question the truth of those suppositions which chymists and the *Peripatetics*, without proof, take for granted; and upon which depends the validity of the inferences they draw from their experiments.

## S E C T. III.

**I** Proceed now to consider the experiments themselves, wherein our opponents usually triumph and glory. And these will the rather deserve a serious examination; because those who alledge them, do it with so much confidence and ostentation, that they have hitherto impos'd upon almost all persons, without excepting philosophers and physicians themselves, who have read their books, or heard them talk. For some learned men have been content rather to believe what these so boldly affirm, than be at the trouble and charge to try whether it were true or no. Others again, who have curiosity enough to examine the truth of what is averr'd, want skill and opportunity to do what they desire; whilst the generality, even of sensible men, seeing the chymists actually perform many strange things, and, among others, resolve compound bodies into several substances, not known by former philosophers to be contained in them; and hearing with what confidence chymists aver the substances, thus obtain'd from compound bodies, by the fire, to be true elements or hypostatical principles of them, they are forward to think it but just to credit the skilful artists in their own art; especially when those things, whose nature they so confidently take upon them to teach others, are productions of their own skill, and such as others know not what to make of.

But we must not suffer our selves to be impos'd upon by hard names or bold assertions; nor to be dazled with that light which shou'd but assist us to discern things the more clearly. To help in the production of bodies, is not to understand by them. Thus men, for being fathers of children, are not the better acquainted with the number and nature of the parts that constitute a child's body.

No precise  
number of ele-  
ments fixt.

It does not appear, that three is precisely and universally the number of the distinct substances or elements, into which all mix'd bodies are resolvable by fire.

If it be granted, that the elements, at first, consisted of certain small primary coalitions of the minute particles of matter into corpuscles, very numerous, and very like each other; it will not be absurd to

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conceive, that such primary masses may be of far more sorts than three or five; and consequently we need not suppose, that in every compound body there shou'd be found just three sorts of such primitive coalitions. *Chymistry.*

And if, according to this notion, we allow a considerable number of different elements; it seems very possible, that to the constitution of one sort of mix'd bodies, two kinds of elementary ones may suffice; as we lately saw in that most durable substance, glass; that another sort of mix'd bodies may be compos'd of three elements, another of four, another of five, &c. so that upon this supposition, there can be no determinate number of elements assign'd; it being very probable, that some concretes consist of fewer, some of more. Nay, it does not seem impossible, according to these principles, that there may be two sorts of mix'd bodies; the one whereof may have none of the same elements the other consists of; as we often see, two words, whereof the one has not any any of the letters to be met with in the other; or as happens in electuaries, wherein no ingredient, except sugar, is common to any two of them.

And since it appears, from the permanency of gold and silver, that even corpuscles, not of an elementary, but compound nature, may be of so durable a texture, as to remain indissoluble in the ordinary analysis, that chymists make of bodies by the fire; 'tis not impossible, that tho' there were but three elements, yet there may be a greater number of bodies, which the usual analysis will not discover to be elementary.

It does not, indeed, sufficiently appear from the common chymical experiments, that there is any one determinate number of elements to be uniformly met with, in all the several sorts of bodies allow'd to be perfectly mix'd.

There are several bodies, which I cou'd never see divided, by fire, into so many as three elementary substances. I would fain see that fix'd and noble metal, gold, separated into salt, sulphur, and mercury; and if any man will submit to a competent forfeiture, in case of failing, I shall willingly, if he succeeds, pay for both the materials and bear the charges of such an experiment. I do not, indeed, after what I have try'd my self, peremptorily deny, that there may, out of gold, be extracted a certain substance, which chymists call its tincture, or sulphur; and which deprives the remaining body of its usual colour. Nor am I sure, that there cannot be drawn, out of the same metal, a real quick and running mercury. But for the salt of gold, I never could either see it, or be satisfied, by the relation of any credible eye-witness, that there was such a thing separated. And for the several processes, which promise that effect, the materials to be wrought upon are somewhat too precious and costly to waft upon adventures, whereof not only the success is doubtful, but the very possibility not hitherto demonstrated. Yet that which most deters me from such try-



Chymistry.

tryals is, not that they are chargeable, but unsatisfactory, tho' they should succeed. For the extraction of this golden salt, being, in chymical processes, prescribed to be obtain'd by corrosive menstrua, or the intervention of other saline bodies; it will remain doubtful, whether the salt produc'd be that of gold it self, or of the saline bodies or spirits, employed to prepare it; for that such disguizes of metals often impose upon artists, is no new thing in chymistry. I would, likewise, willingly see the three principles separated from the pure sort of virgin-sand, from osteocolla, from refined silver, from pure quick-silver, and from *Venetian* talc; which latter, by long detention in an extreme reverberatory heat, I cou'd but divide into smaller particles, not the constituent principles. Nay, when I caus'd it to be very long kept in a glass-house fire, it came out in the figure its lumps had, when put in; tho' alter'd to an almost amethystine colour. I dare not, indeed, absolutely affirm it impossible to analyze these bodies into their *tria prima*; yet because neither my own experiments, nor any competent testimony hath hitherto either taught me how such an analysis may be, or satisfied me that it hath been made; I must take the liberty to doubt, till the chymists prove it, or give us intelligible and practicable processes to perform what they pretend. For whilst they affect that enigmatical obscurity, with which they puzzle the readers of their processes, concerning the analytical preparation of gold or mercury; they leave wary persons much unsatisfied, whether or no the different substances, they promise to produce, be truly the hypostatical principle, or only some intermixtures of the divided bodies, with those employ'd to work upon them; as is evident in the seeming crystals of silver, and those of mercury; which, tho' by some, inconsiderately supposed to be the salts of those metals, are plainly but mixtures of the metalline bodies, with the saline parts of *Aqua fortis*, or other corrosive liquors; as is evident by their being reducible into what they were before.

And I cannot but confess, I have often wonder'd that chymists should so confidently pretend to resolve all metalline and other mineral bodies into salt, sulphur, and mercury. For 'tis a saying almost proverbial among the adept; and the famous *Roger Bacon* has particularly adopted it; that 'tis easier to make gold, than to destroy it. And I fear that gold is not the only mineral from which chymists, in vain, attempt to separate their three principles. I know, indeed, the learned *Sennertus* says, "there is salt and sulphur contain'd in all mix'd bodies; and 'tis well known that skilful chymists can extract them thence;" but, by his favour, I must see very good proof, before I can believe such bold general assertions: and he who wou'd convince me of their truth, must first teach me some real practicable way of separating salt and sulphur from gold, silver, and those many different sorts of stones, that a violent fire brings to fusion. And not only I, for my own part, never saw any of the bodies, just mention'd, so

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resolv'd; but *Helmont* himself declares the same of sand, flint, and some stones. Nay, *Quercetan*, tho' a grand stickler for the *tria prima*, confesses, that diamonds are irresoluble. And as for metalline mercuries, I remember a famous and ingenious artist, who had long been chymist to a great monarch, assured me, he had never really extracted a true and running mercury out of metals; nor had seen it done by any man else. And tho' gold is of all metals that whose mercury the chymists have most endeavoured to extract, and which they the most boast themselves to have extracted; yet the experienced *Angelus Sala* avers the thing impossible: he adds, that himself had seen much labour in vain bestowed upon that design; and that he had often seen the tricks and impostures of cheating alchymists detected in this affair. But the greatest part of those who are fond of such *Charlatans*, being unskilful, or credulous, or both; 'tis very easy for such as have some skill, much craft, more boldness, and no conscience, to impose upon them; and, therefore, tho' many profess'd chymists, and persons of quality, have told me, that they have made, or seen the mercury of gold, or of some other metal; yet I have been still apt to fear, that either these persons have had a design to deceive others, or have not had skill and circumspection enough to keep themselves from being deceived.

I once devised an experiment, innocently to deceive some persons, and let them see how little is to be built upon the affirmation of those, who are either unskilful, or unwary, when they tell us, they have seen chymists make the mercury of a metal: and to render this the more evident, I made my experiment much more slight, short, and simple, than are the chymists usual processes to extract metalline mercuries; their operations being commonly more elaborate and intricate, and by requiring a much longer time, give the alchymist a greater opportunity to cozen. And, to make my experiment look the more like a true analysis, I not only pretend, as well as others, to extract a mercury from the metal I work upon; but likewise to separate a large proportion of manifest and inflammable sulphur. I take, then, the filings of copper, common sublimate powder'd, and sal-armoniac, of each about a dram or two; and these being well mix'd together, I put them into a glass urinal; which (having first stopp'd it with cotton) to avoid the noxious fumes, I approach, by degrees, to a competent fire of well-kindled coals, or to the flame of a candle; and, after a while, the bottom of the glass being held just upon the kindled coals, or in the flame; you may, in about a quarter of an hour, or less, perceive in the bottom of the glass some running mercury; and if you then take away the glass, and break it, you shall find a parcel of quick-silver, perhaps altogether, or perhaps part of it only, in the pores of the solid mass. You will find too, that the remaining lump being held to the flame of the candle, will readily burn with a greenish flame, and soon after

To make a  
shew of produ-  
cing a metal-  
line mercury.

Chymistry.

acquire in the air a greenish blue; which being the colour ascribed to copper, when its body is unlock'd, 'tis easy to persuade men, that this is the true sulphur of that metal; especially since not only the salts may be suppos'd to be flown away, or sublimed to the upper part of the glass, whose inside will commonly appear whitened by them; but the metal seems to be quite destroyed; the copper no longer appearing in a metalline form, but almost in that of a resinous lump. The case, however, is only this; the saline parts of the sublimate, together with the sal-armoniac, excited and actuated by the vehement heat, fall upon the copper, whereby the small parts of the mercury being freed from the salts that kept them asunder, and by the heat toss'd up and down, convene, after many occurrences, into a conspicuous mass of liquor: and as for the salts, some of the more volatile of them subliming, the others corrode the copper, and uniting themselves with it, strangely alter, and disguise its metalline form, and therewith compose a new kind of concrete, inflammable like sulphur.

More than  
three principles  
afforded by  
some bodies.

But to proceed; as there are some bodies which yield not so many as three principles; so there are many others, that, in their resolution, exhibit more. From our doctrine of the primary association of the small particles of matter, it seems probable, that of such elementary corpuscles, there may be more sorts than three, or four, or five. And if corpuscles of a compound nature, may, in all the usual examples of chymists, pass for elementary; it seems not impossible, that as *Aqua fortis*, or *Aqua regia*, will make a separation of dissolv'd silver and gold, tho' the fire cannot; so there may be some agent found so subtile and powerful, at least in respect of those particular compound corpuscles, as to be able to resolve them into the more simple ones, whereof they consist; and, consequently, increase the number of the distinct substances, whereinto the mixed body has been hitherto thought resolvable. And if that be true we formerly mention'd, of *Helmont's* alkahest, which divides bodies into other distinct substances, both as to number and nature, than doth the fire; it will greatly countenance my conjecture. But confining our selves to such ways of analyzing mix'd bodies, as are already known to chymists; it may, without absurdity, be question'd, whether, besides those grosser elements of bodies, which they call salt, sulphur, and mercury, there may not be ingredients of a more subtile nature; which being extremely small, and not in themselves visible, may escape unheeded, at the junctures of the vessels employed in distillation. For we may well suspect there are several sorts of bodies, not immediate objects of any of our senses; since we see, that not only those little corpuscles, which issue out of the load-stone, produce surprizing effects; but the effuvia of amber, jet, and other electrical concretes, tho', by their operations upon the particular bodies, dispos'd to receive their action, they seem to fall under the



cognizance of our sight, yet do they not any way, as electrical, immediately affect us. *Chymistry.*

But to consider only the sensible ingredients of mixed bodies; it seems questionable, whether from grapes variously order'd, there may not be drawn more distinct substances by the help of the fire, than from most other mixed bodies; for the grapes themselves being dry'd into raisins, and distill'd, will, besides alkali, phlegm, and earth, yield a considerable quantity of an empyreumatical oil, and a spirit of a very different nature from that of wine: the unfermented juice of grapes, also, affords other liquors by distillation, than wine doth. The same juice, after fermentation, yields an inflammable spirit; which, if competently rectified, will burn entirely away. The same fermented juice degenerating into vinegar, yields an acid and corroding spirit; and tunned up, it arms it self with tartar, out of which may be separated, as out of other bodies, phlegm, spirit, oil, salt, and earth: not to mention what substances may be drawn from the vine it self, probably different from those which are separated from tartar, which is a body of a particular kind. What force soever this instance be allow'd, towards proving that some bodies yield more elements than others; it can scarce be deny'd, that the major part of the bodies, divisible into elements, afford more than three. For, besides those which the chymists name hypostatical, most bodies contain two others, phlegm and earth; which concurring, as well as the rest, to the constitution of mixed bodies, and being as generally, if not more, found in their analysis; I see no sufficient cause, why they should be excluded from the number of elements. Nor will it suffice to object, with the *Paracelsians*, that the *tria prima* are the most useful elements; and the earth and water but worthless and unactive: for elements being call'd so in relation to the constitution of mixed bodies; it should be upon the account of its proving an ingredient, not on account of its use, that any thing is affirmed, or deny'd to be an element. And as for the pretended uselessness of earth and water, it should be consider'd, that usefulness, or the want of it, denotes only a respect, or relation to us; and, therefore, the presence, or absence of it, alters not the intrinsic nature of the thing. The noxious teeth of vipers are, for ought I know, useless to us; yet are acknowledged parts of their bodies: and it were hard to shew, of what greater use to us than phlegm or earth, are those undiscern'd stars, which our telescopes discover; yet we cannot but acknowledge them constituent, and considerable parts of the universe. However, the phlegm and earth are necessary to constitute the body whence they are separated; and, consequently, if that body be not useless to us, those constituent parts, without which it could not have been that body, may be said to be useful to us; and tho' the earth and water be not so conspicuously operative, as the other three principles; yet, in this case, it will not be amiss to remember the

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fable of the dangerous sedition of the hands and legs, and other more busie parts of the body, against the seemingly unactive stomach. In a word, since earth and water appear as clearly and as generally as the other principles, upon the resolution of bodies, to be ingredients therein; and since they are useful, if not immediately to us, to the bodies they constitute; to exclude them out of the number of elements, is not to imitate nature.

*Earth and water to be reckoned among the chymical principles.*

And here I cannot but take notice, that the great argument which the chymists employ to debase earth and water, and make them look'd upon as uselefs and unworthy to be reckon'd among the principles of mix'd bodies, is, that they are not endowed with specific properties, but only with elementary qualities; of which they speak very slightly, as of qualities contemptible and unactive: but I see no sufficient reason for this practice; since heat is confess'd to be an elementary quality; for, that numerous considerable things are performed by it, is manifest to those who duly consider the various phenomena, wherein it intervenes as a principal actor: and almost all the operations and productions of chymists are perform'd and obtain'd chiefly by its means. And as for cold it self, upon whose account they so despise the earth and water; if they please to read in the history of the voyages of our *English* and *Dutch* navigators to *Nova Zembla*, and other northern regions, what stupendous things may be effected by cold; they would not, perhaps, think it so despicable. The conservation of the texture of many bodies, both animate and inanimate, so greatly depends upon the convenient motion, both of their own fluid and looser parts, and of the bodies which surround them, that we see not only the animal œconomy frequently disordered by the immoderate or unseasonable coldness of the air; but the solid and durable body of iron it self; for if you take a slender piece of steel, and after having brought it in the fire to a white heat, suffer it afterwards to cool leisurely in the air, it will, when cold, be much of the same hardness it was of before; but if, as soon as you remove it from the fire, you plunge it into cold water, it will, upon the sudden refrigeration, acquire a much greater hardness, and become manifestly brittle. And to shew, that this is not owing to any peculiar quality in the water, or other liquor, or unctuous matter, wherein such heated steel is usually quenched, that it may be temper'd; I know a very skilful tradesman who frequently harden'd steel, by suddenly cooling it in a body that is neither a liquor, nor so much as moist. Hence it appears, that water is not always so inefficacious and contemptible a body as our chymists would have it pass for.

*And at least one certain alkaline, if not also an acid, spirit.*

But tho' I think it evident, that earth and phlegm are to be reckon'd among the elements of most animal and vegetable bodies; yet it is not upon this account that I suppose several bodies resolvable into more substances than three. For there are two experiments, which I have sometimes made, to shew, that, at least, some mix'd bodies are

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divisible into more distinct substances than five. Out of two distill'd liquors, which pass for elements of the body, whence they are drawn. I can, without addition, make a true yellow and inflammable sulphur, tho' the two liquors remain afterwards distinct; and having long observed, that by the distillation of several woods, both in ordinary and in some unusual sorts of vessels, the spirits that came over, in plenty, had, besides a strong taste, to be met with in the empyreumatical spirits of many other bodies, an acidity almost like that of vinegar; I suspected, that tho' the sourish liquor, distill'd from box-wood, for instance, be look'd upon by chymists as barely the spirit of it; and therefore as one single element or principle, does yet really consist of two different substances, and may be divided into them; and consequently, that such wood, and other mix'd bodies as abound with such a vinegar, may be said to consist of one element or principle more than the chymists are yet aware of. I, therefore, distilled a quantity of box-wood *per se*, and slowly rectified the sourish spirit, the better to free it both from oil and phlegm; then cast into this rectified liquor a convenient quantity of powder'd coral, expecting that the acid part of the liquor wou'd corrode it, and being associated therewith, be so retained by it, that the part of the liquor, which was not of an acid nature, nor fit to fasten upon the coral, would be permitted to ascend alone. And, accordingly, having gently abstracted the liquor from the coral, there came over a spirit of a strong smell, and of a very piercing taste, but without any sourness; and which was, in several qualities, manifestly different, not only from a spirit of vinegar, but from some spirit of the same wood, that I purposely kept by me, without depriving it of its acid ingredient. This sour spirit of box would not only, as I just said, dissolve corals, which the other would not fasten on; but being poured upon salt of tartar, would immediately boil and hiss, tho' the other would lie quietly upon it. The acid spirit poured upon minium, made a sugar of lead, which I did not find the other to do; some drops of this penetrating spirit being poured upon a few drops of syrup of violets, seem'd rather to dilute than otherwise alter the colour; whereas the acid spirit turn'd the syrup reddish, and wou'd probably have made it of as pure a red as acid salts usually do, had not the operation been hinder'd by the other spirit. A few drops of the compound spirit, shaken into a large quantity of the infusion of *Lignum ne-  
phriticum*, presently destroy'd all its bluish colour; whilst the other spirit wou'd suffer it to remain: and having pour'd fair water upon the coral that remain'd in the bottom of the glass, wherein I had rectified the double spirit, first drawn from the box; I found that the acid spirit had really dissolv'd and coagulated with the coral. For by the effusion of fair water, I obtain'd a solution, which was red; whence the water being evaporated, there remain'd a soluble substance much like the salt of coral; as chymists call that magistery of it, which they make by dissolving it in common spirit of vinegar, and

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abstracting the menstruum *ad siccitatem*. The simple spirit of box, if chymists will have it therefore saline, because it has a strong taste, furnishes us with a new kind of saline bodies, different from those hitherto taken notice of. For tho' of the three chief sorts of salts, the acid, the alkaline, and the sulphureous, there is no one that seems to be at amity with both the other two; yet I did not find but that the simple spirit of box agreed very well both with the acid and other salts. For tho' it wou'd lie very quiet with salt of tartar, spirit of urine, and other bodies, whose salts were either of an alkaline or fugitive nature; yet did not oil of vitriol it self produce any hissing or effervescence with it.

This experiment teaches us a method whereby we may prepare a various sorts of new spirits, which, tho' more simple than any supposed elementary, are manifestly endowed with peculiar and powerful qualities; some of which may, probably, be of considerable use in physic, as well alone, as associated with other things; as may be guessed by the redness of that solution, the four spirit made of coral, &c. and, perhaps, we may here, with the same success, use other alkaline bodies, instead of coral. From hence, however, I infer, that there are many compound bodies which may be resolved into four such different substances, which merit the name of principles, as well as those to which the chymists freely allow it. For since they scruple not to reckon, that which I call the compound spirit of box, for the spirit; or as others would have it, the mercury of that wood; I see not why the acid liquor, and the other, shou'd not each of them, especially the latter, be look'd upon as more deserving to be called an elementary principle; since it must needs be of a more simple nature than the liquor which was found to be divisible into that and the acid spirit. This further use may be also made of our experiment; to give us a suspicion, that since a liquor, reputed by the chymists to be, without dispute, homogeneous, is, by so slight a way, divisible into two distinct and more simple ingredients; some more skilful or happier expedient may be found, either further to divide one of these spirits, or to resolve some, at least, of those other ingredients of mixed bodies, that have hitherto pass'd, among chymists, for their elements and principles.

## S E C T. IV.

The ambiguity of chymical writers considered.

HAVING thus dispatch'd what we had to say, as to the number of the distinct substances separable from mixed bodies by the fire, I come to consider the nature of them; and to shew, that tho' they seem homogeneous bodies, yet they have not the purity and

simplicity that is requisite in elements. But the confidence where-*Chymistry.*  
with chymists call each of these substances by the name of salt, sulphur, or mercury, and the intolerable ambiguity they allow themselves in their writings, make it here necessary to complain of their unreasonable practice of playing with words. Several authors among them, will often give many names to one thing; and some of these shall, perhaps, be such, as much more properly signify some distinct body of another kind: nay, even in technical words, or terms of art, they refrain not from this liberty; but will, as we observ'd, call the same substance sometimes the sulphur, and sometimes the mercury of a body. The descriptions they give us of mercury, as of a principle, or ingredient of mix'd bodies, are so intricate, that even those who have endeavour'd to polish and illustrate the notions of the chymists, are reduced to confess, they know not what to make of it.

But whatever these men may promise themselves from a canting way of delivering the principles of nature; they will find the major part of knowing persons so vain, as, when they understand not what they read, to conclude, that it is rather the writer's fault, than their own. And those who are so ambitious to be admir'd by the vulgar and ignorant, that rather than go without their applause, will expose themselves to the contempt of the learned; shall, by my consent, freely enjoy their option. As for the scruple of the mystical writers to communicate their knowledge, they might, less to their own disparagement, and to the trouble of their readers, have conceal'd it, by writing no books, than by writing bad ones. It were a temptation to say, that the chymists write thus darkly, not because they think their notions too precious to be explain'd; but because they fear, if they were explain'd, men would discern them to be vain and frivolous. And, indeed, I fear, that the chief reason why chymists have written so obscurely of their three principles, may be, that not having clear and distinct notions of the matter themselves, they cannot write otherwise than confusedly about it: not to mention that several of them, conscious of the invalidity of their doctrine, might well discern, that they could scarce avoid a confutation, but by keeping themselves from being clearly understood. But tho' much may be said to excuse the chymists, when they write darkly and enigmatically about the preparation of their elixir, and some few other grand *Arcana*; yet when they pretend to teach the general principles of natural philosophy, this equivocal way of writing is not to be endured. For in such speculative enquiries, wherein the naked knowledge of the truth is the thing principally aim'd at, what does he teach me worth thanks, who does not, if he can, make his notions intelligible to me; but by mystical terms, and ambiguous phrases, darkens what he should clear up? And if the matter of the philosopher's stone, and the manner of preparing it,

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it, be such mysteries, as they would have the world believe; they may write intelligibly and clearly of the principles of mix'd bodies in general, without discovering what they call the great work. In short, I could wish, that learned men would conspire together to make these deluding writers sensible, they must no longer hope, with impunity to abuse the world. For whilst they are quietly permitted to publish books with promising titles, and therein to assert what they please, and contradict others, and even themselves, with as little danger of being confuted, as of being understood; they are encouraged to raise themselves a name, by playing upon their readers; who are only the ignorant and credulous, and always admire most what they least understand. But if judicious men, skill'd in chymical affairs, shall once agree to write clearly and plainly of them, and thereby keep others from being impos'd upon by dark, empty words; 'tis to be hoped, that these obscure authors, finding that they can no longer write impertinently and absurdly, without being laugh'd at for it, will be reduced either to write nothing, or books that may teach us something.

Bodies seemingly homogeneous, not elementary.

However, that which I am now entering upon, being the consideration of the things themselves, into which chymists resolve mixed bodies by the fire; if I can shew that these are not of an elementary nature, it will be no great matter what names particular chymists have been pleas'd to give them.

I say then, that as generally as chymists appeal to experience, and as confidently as they alledge the several substances separated by the fire from a mixed body, for a sufficient proof of their being its component elements; yet those different substances are, many of them, far from an elementary simplicity, and may be still look'd upon as mixed bodies: the greater part of them also retaining the nature of those concretes, whence they were forced.

But before I descend to particulars, I think it convenient to observe, first, that *Helmont* mentions it as a notable thing; and I take it to be a very considerable one; that tho' the distill'd oil of oil-olive, drawn *per se*, is, as I have try'd, of a very sharp and fretting quality, and of an odious tast; he tells us, that simple oil being only digested with *Paracelsus's Sal circulatum*, is reduced into dissimilar parts, and yields a sweet oil, very different from the distill'd oil; as also, that, by the same way, there may be separated from wine, a very sweet and gentle spirit, partaking of a far different and nobler quality, than that which is immediately drawn by distillation, and call'd dephlegmed *Aqua vite*; from whose acrimony this other spirit is exceedingly remote, altho' the *Sal circulatum*, that makes these analyses, be separated from the analyz'd bodies, in the same weight, and with the same qualities it had before. This affirmation of *Helmont* if we admit for true, we must acknowledge, that there may be a very great disparity betwixt substances of the same denomination, separable from

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compound bodies; for besides the differences I shall hereafter take notice of, betwixt those distilled oils that are commonly known to chymists; it appears from hence, that by means of the *Sal circulatum*, there is quite another sort of oils, obtainable from the same body: and who knows that there are not other agents in nature, by whose help there may, whether by transmutation, or otherwise, be obtained from the bodies vulgarly called mixed, oils, or other substances, different from those of the same denomination, known either to vulgar chymists, or even to *Helmont* himself?

Secondly, if the opinion of *Leucippus*, *Democritus*, and other ancient and modern philosophers, be true, that our culinary fire, such as chymists use, consists of numberless little bodies in swift motion, which by their smallness and rapidity are able to permeate the most solid and compact bodies; it will be reasonable to suppose, that multitudes of these fiery corpuscles, getting in at the pores of the containing glass, may associate themselves with the parts of the mix'd body whereon they work, and with them constitute new kinds of compounds, according as the shape, size, and other properties of the parts of the dissipated body, happen to dispose them, with regard to such combinations. And of these, also, there may be the greater number, if we grant that such corpuscles of the fire are not all of the same magnitude or figure. And, indeed, some particular experiments have induced me to think, that the particles of an open fire, working upon some bodies, may really associate themselves therewith, and add to their quantity\*. Tho' I am not sure, when it operates on bodies included in glass vessels, that the fiery corpuscles actually pass thro' the substance of the glass.

But there are some bodies, as gold and silver, which do not, in the usual examinations made by fire, discover themselves to be mix'd: and if a re-compound body be separable into several substances by the fire, it may be resolved into such as are neither elementary, nor such as it was upon its last mixture composed of; but into new kinds of mixtures. Of this I have already produced some examples in soap, sugar of lead, and vitriol. Now, if we consider, that there are some bodies, as well natural as factitious, manifestly re-compounded; that in the bowels of the earth nature may, as we see she sometimes does, make strange mixtures; that some animals are nourished with others, and some with plants; and that these have their nutriment and growth, either from a certain nitrous juice harbour'd in the pores of the earth; or from the excrements

\* The sun's rays will insinuate themselves into bodies, so as greatly to increase their weight. *M. Homberg*, by exposing four ounces of *Regulus Martis* in powder, at the distance of about a foot and a half from the focus of the duke of

*Orleans's* large burning-glass, found it, after an hour's stay there, augmented by about  $\frac{1}{16}$  upon the balance; notwithstanding what was dissipated in smoke. *French Memoirs*, A. 1705. p. 125.

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of animals; or from the putrefied bodies, either of living creatures, or vegetables; or from other substances of a compound nature: if, I say, we consider this, it may seem probable, that there are among the works of nature, a greater number of re-compound bodies, than men usually take notice of. And, indeed, as I have formerly, also, observed, it does not appear, that all mixtures must be of elementary bodies; but it seems far more probable, that there are several sorts of compounds, even in regard of their ingredients, consider'd antecedently to their mixture. For tho' some seem to be made up by the immediate coalitions of the elements, or principles themselves, and may therefore be called *mista primaria*; yet, it seems, that many other bodies are mix'd at the second hand; their immediate ingredients not being elementary. And from many of these secondary sorts of mix'd bodies, may result, by a farther composition, a third sort; and so onwards. Nor is it improbable, that some bodies are made up of mix'd ones, not all of the same order; as for instance, a concrete may consist of ingredients, whereof the one may have been a primary, the other a secondary mix'd body; (as I have in native cinabar found a courser part, that seems more properly to be ore, a combustible sulphur, and a running mercury;) or, perhaps, without any ingredient of this latter sort, it may be compos'd of mix'd bodies, some of them of the first, and some of the third kind. And this may be illustrated, by reflecting upon what happens in the chymical preparations, of some of those medicines called *Bezoardica*. For first, from antimony and iron, which may be look'd upon as *prima mista*, they compound a starry regulus; to which they put, according to their intention, either gold or silver; and this makes with it a new and further composition. Then they add sublimate, which is it self a re-compounded body; and from this sublimate, and the other metalline mixtures, draw a liquor; which may be allowed to be of a yet more compounded nature; if it be true, as chymists affirm, that by this art some of the gold or silver mix'd with the regulus, may be carried over the helm with it, by the sublimate; as indeed a skilful and candid person complained to me a while since, that a friend of his, and mine, having, by such a way, brought over a great deal of gold, in hopes to do something further with it, which might be gainful to him; has not only miss'd of his aim, but is unable to recover the volatiliz'd gold, out of the antimonial butter wherewith it is strictly united.

Now, if a compound body consist of ingredients not merely elementary; it is easy to conceive, that the substances into which the fire dissolves it, tho' seemingly homogeneous, may be of a compound nature; those parts of each body that are most of kin, associating themselves into a compound of a new kind. Thus when, for example, I have caus'd vitriol, sal-armoniac, and salt-petre, to be mingled and distill'd together, the liquor that came over did not manifest it self

to be either spirit of nitre, or of sal-armoniac, or of vitriol. For none of those would dissolve crude gold, which yet my liquor would readily do; and thereby shewed it self to be a new compound, consisting, at least, of spirit of nitre, and sal-armoniac; for the latter dissolved in the former, will work on gold; which, nevertheless, are not by any known way separable; and, consequently, would not pass for a mixed body, if we our selves did not, to obtain it, put and distil together different concretes, whose distinct operations were known before-hand. And suspecting the common oil of vitriol to be no such simple liquor as chymists presume, I mix'd it with an equal, or a double quantity of common oil of turpentine; and having carefully, for the experiment is nice, and somewhat dangerous, distill'd the mixture in a small glass retort, I obtained, according to my desire, besides the two liquors I had put in, a considerable quantity of a certain substance, which sticking all about the neck of the retort, discover'd it self to be sulphur, not only by a very strong sulphureous smell, and by the colour of brimstone, but also by this, that being put upon a coal, it was immediately kindled, and burnt like common sulphur. So that from this experiment it appears, that a real sulphur may be made, by the conjunction of two such substances, as chymists take for elementary, and which did neither of them a-part seem to contain any such body; or that oil of vitriol, tho' a distill'd liquor, and taken for part of the saline principle of the concrete that yields it, may contain, besides its saline portion, a sulphur like common brimstone, which it self is hardly an uncompound body.

I might here again repeat, that as there may be more elements than five or six, so the elements of one body may be different from those of another; whence it would follow, that from the resolution of re-compound bodies, there may result mixtures wholly of a new kind, by the coalition of elements, that never, perhaps, convened before. But I proceed to observe, that the fire does not always barely resolve, or take asunder, but may, also, after a new manner, mix and compound together the parts of the body dissipated by it.

*Fire may compound as well as dissipate the parts of bodies.*

This is so obvious, that I cannot but wonder, it should be no more taken notice of. For when wood, by being burnt, is dissipated into smoke and ashes, that smoke composes soot; which is so far from being any one of the principles of the wood, that, as I noted above, you may, by a farther analysis, separate five or six distinct substances from it. And as for the remaining ashes, the chymists themselves teach us, that by a farther degree of fire, they may be indissolubly united into glass. 'Tis true, that the analysis, which the chymists principally build upon, is made not in the open air, but in close vessels; however, the examples lately produced, will lead us to suspect, that heat may as well compound, as dissipate the parts of mixed bodies. I have known a vitrification made, even in close vessels. The flowers of antimony, and those of sulphur, are very mixed bodies,



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tho' they ascend in close vessels; and 'twas in stopped glasses that I raised the whole body of camphire. It may be objected, indeed, that these examples are of bodies forc'd up in a dry, not a fluid form, like the liquors obtain'd by distillation. But 'tis possible a body may be chang'd from solid to fluid, or from fluid to solid, without being otherwise much alter'd; as appears by the readiness wherewith, in winter, the same individual substance is hardened into brittle ice, and thaw'd again into fluid water. Besides this, common quick-silver it self, which the most eminent chymists confess to be a mix'd body, may be driven over the helm in its pristine form, and consequently in that of a liquor. And certainly 'tis possible, that very compounded bodies may concur to constitute liquors; for I have found it possible, by the help of a certain menstruum, to distil gold it self thro' a retort, even with a moderate fire. And butter of antimony, if carefully rectified, may be reduced into a very clear liquor; yet when a quantity of fair water is thrown upon it, there will quickly precipitate a ponderous emetic calx, which before made a considerable part of the liquor, and is indeed, an antimonial body, carried over and kept dissolved by the salts of the sublimate; and consequently a compounded one, as appears from examining this white powder by a skilful reduction. And to shew, that bodies, as compounded as the flowers of brimstone, may concur to constitute distill'd liquors; which a mix'd body may be brought over the helm without corrosive salts; I have ways of bringing over flowers of brimstone, and perhaps even mineral sulphurs, wherein I employ none but oleaginous bodies to make volatile liquors; in which not only the colour, but the smell, and some operations, manifest, there is brought over a sulphur that makes part of the liquor.

And here we ought, again, to remember, that the qualities or accidents, upon account whereof chymists call a portion of matter by the name of one of their principles, are not such, but that as great may be produced by the changes of texture, and other alterations, which the fire makes in the small parts of a body. I have already prov'd, by what happens to plants, fed only with fair water, that by changing the disposition of the component parts of a body, nature is able to effect as great changes in a parcel of matter, reputed similar, as those requisite to denominate one of the *tria prima*. And tho' *Helmont* calls the fire, the artificial death of things; and altho' it has been supposed, that fire can never generate any thing but fire; yet we ought to consider, how many new sorts of mix'd bodies chymists themselves have produced by means of the fire; and particularly that glass is not only produced by the manifest action of the fire, but has never, for ought we know, been produced any other way. And indeed it seems but an inconsiderate assertion of some *Helmontians*, that every sort of body, of a peculiar denomination, must be produced by some seminal power. Nor need it much move us, that there are some, who look upon whatsoever the fire is employ'd to produce not as natural, but

but artificial bodies. For there is not always such a difference, as many imagine, betwixt the one and the other; and it is not so easie as they think, clearly to assign what it is, that properly, constantly, and sufficiently discriminates them. A thing is commonly term'd artificial, when a parcel of matter is, by the artificer's hand or tools, or both, brought to such a shape or form as he design'd; whilst in many of the chymical productions, the effect would be produced, whether the artificer intended it or no; and is often different from what he intended or expected; and the instruments employed, are not tools artificially fashion'd and shap'd, like those of tradesmen, for some particular work; but, for the most part, agents of nature's own providing; receiving their chief powers of operation from their own nature or texture, not the artificer. The fire is as well a natural agent as seed; and the chymist, who employs it, only applies natural agents to patients, which, thus brought together, and acting according to their respective natures, perform the work themselves: as fruit is a natural production, tho' the gardener bring and fasten together the sciens and stock, &c. But very slight qualities may serve to denominate a chymical principle. For when they analyze a compound body, by the fire, and obtain a substance inflammable, that will not mix with water; they presently call it sulphur; what comes over sapid and dissoluble in water, passes for salt; and what is fix'd and indissoluble in water, that, they name earth: and all the volatile substances they know not what to make of, they call mercury. But that these qualities may either be produced otherwise than by such as they call seminal agents; or may belong to bodies of a compound nature; appears from glass made of ashes, where the strong-tasted alkaline salt, joining with the earth, becomes insipid, and with it constitutes a body, which, tho' also dry, fix'd, and indissoluble in water, is yet manifestly a mix'd body; and made so by the fire it self. *Helmont* tells us of a way to transmute oil of cinnamon, &c. wholly into a volatile salt, by a bare mixture of its own alkaline salt; from whence, if it be true, as I have reason to believe, I may argue, that since a substance, that is as well saline and volatile as the salts of harts-horn, blood, &c. which pass for elementary, is producible by the fire; and since this volatile salt is really compounded of a chymical oil and a fixed salt; the one made volatile by the other, and both associated by the fire; it may well be suspected, that other substances arising from the separation of bodies by the fire, may be new sorts of mixtures, and consist of ingredients of different natures. Thus, particularly, I have, sometimes, suspected, that since the volatile salts of blood, harts-horn, &c. are fugitive, and of an exceeding strong smell; either the chymists erroneously ascribe all odours to sulphurs, or that such salts consist of some oily parts well incorporated with the saline ones. And the like conjecture I have, also, made as to spirit of vinegar; which, tho' the chymists think one of the principles of that body; and tho' being an acid spirit, it seems

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to be much less of kin, than volatile salts, to sulphurs; yet not to mention its piercing smell, which I know not with what congruity the chymists will deduce from salt; I wonder they have not taken notice of what their own *Tyrocinium chymicum* teaches, concerning the distillation of *Saccharum Saturni*; out of which, *Beguinus* assures us, that he distill'd, besides a very fine spirit, no less than two oils; the one blood-red and ponderous; but the other swimming upon the top of the spirit, and of a yellow colour. And tho' I remember not, that I have had two distinct oils from sugar of lead; yet that it will, tho' distill'd without addition, yield some oil, I find by experience. I know the chymists will be apt to pretend, that these oils are but the volatiliz'd sulphur of lead, and will, perhaps, argue it from what *Beguinus* relates, that when the distillation is ended, you find a *Caput mortuum* extremely black, and good for nothing; as if the body, or at least, the chief part of the metal it self, were, by the distillation, carried over the helm. But as *Saccharum Saturni*, is a kind of magistery, made only by calcining lead *per se*, dissolving it in distill'd vinegar, and crystallizing the solution; I found, upon examination, the *Caput mortuum*, slighted by *Beguinus*, to be so undeserving the character he gives it, that I venture to say, this oil either formerly concurr'd to constitute the spirit of vinegar, so that what passes for a chymical principle, may yet be further resolvable into distinct substances; or that some parts of the spirit, together with others of the lead, may constitute a chymical oil, which, therefore, tho' it pass for homogeneous, may be a compound body; or at least, that by the action of the distill'd vinegar, and the calx of lead, one upon the other, part of the liquor may be transmuted from an acid spirit into an oil.

Chymists must, also, confess, that in the spirit of wine perfectly dephlegm'd, or other fermented liquors, that which they call the sulphur of the concrete, loses by fermentation, that property of oil, (which the chymists likewise take to be the true sulphur of the mixture,) of being immiscible with water. And if we credit *Helmont*, a pound of the purest spirit of wine, may barely, by the help of salt of tartar, be resolv'd or transmuted into scarce half an ounce of salt, and as much elementary water, as amounts to the remaining part of the weight. And it may be doubted, whether that fix'd and alkaline salt, which is so unanimously agreed on to be the saline principle of incinerated bodies, be not, as 'tis alkaline, a production of the fire. For, tho' the taste of tartar seems to argue, that it contains a salt before it be burned; yet that salt being very acid, has a quite different taste from the lixivate salt of calcined tartar. And tho' it be falsely objected against the chymists, that they obtain all the salts they make, by reducing the body they work on into ashes, with violent fires; yet this volatile salt greatly differs from the fix'd alkaline salt I speak of, which seems not producible by any known way without incineration. 'Tis not unknown to chymists, that quick-silver may be precipitated,



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pated, without addition, into a dry powder, that remains so in water. *Chymistry.*  
And some eminent men among them teach, that merely by the fire, quick-silver may, in convenient vessels, be reduced into a thin liquor, like water, and miscible with it. So that by the bare action of the fire, 'tis possible, that the parts of a mix'd body, should be so dispos'd, after new and different manners, that it may be sometimes of one consistence, and sometimes of another; and in one state be dispos'd to mix with water, and in another not. I could also shew, that bodies, from which, a-part, chymists cannot obtain any thing combustible, may, by being associated together, and by the help of the fire, afford an inflammable substance; and that, on the other side, 'tis possible for a body to be inflammable, tho' it would very much puzzle an ordinary chymist, to separate an inflammable ingredient from it: wherefore, since the principles of chymists, may receive their denomination from qualities, which it often exceeds not the power of art, nor always that of the fire, to produce; and since such qualities may be found in bodies that differ so much in other qualities from one another, that they need not be allow'd to agree in that pure and simple nature, which principles ought to have; it may justly be suspected, that many productions of the fire, shew'd us by chymists, as the principles of the concrete that afforded them, may be but a new kind of mix'd bodies. And tho' *Paracelsus*, and some of his followers, have ventur'd to teach, that not only the bodies here below, but the elements themselves, and all the other parts of the universe, are compos'd of salt, sulphur, and mercury; yet the learned *Sennertus*, and all the more wary chymists, have rejected that conceit; and do, many of them, confess, that the *tria prima* are each made up of the four elements; whilst others of them make earth and water, concur with salt, sulphur and mercury, to the constitution of mix'd bodies. So that one sort of these chymists, notwithstanding the specious titles they give to the productions of the fire, do in effect grant what I contend for. And of the other sort, I demand, to what kind of bodies the phlegm and earth, to be met with in chymical resolutions, are to be referr'd? For either they must say, with *Paracelsus*, tho' against their own concessions, as well as against experience, that these are also compos'd of the *tria prima*, whereof they cannot separate any one from either; or else they must confess, that two of the vastest bodies here below, earth and water, are neither of them compos'd of the *tria prima*; and that consequently those three are not the universal and adequate ingredients of all sublunary, nor even of all mix'd bodies. The chief of these chymists, I know, represent, that tho' the distinct substances, into which they divide mix'd bodies by the fire, are not pure and homogeneous; yet since the four elements, into which the *Aristotelians* resolve the like bodies by the same agent, are not simple neither; 'tis as allowable for the chymists, to call the one principles, as for the *Peripatetics* to call the other elements; since  
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*Chymistry.* in both cases, the name is grounded only upon the predominancy of them. This argument indeed is of weight against the *Aristotelians*, but affects not me, who look upon no body as a true principle or element, that is not perfectly homogeneous; but further resolvable into any number of distinct substances, how small soever. And as for the chymists calling a body salt, sulphur, or mercury, upon pretence, that the principle of the same is predominant in it; this is an acknowledgment, that these productions of the fire are yet compounded bodies; tho' whilst this is granted, it is affirm'd, that the reputed salt, sulphur, or mercury, principally consists of one body, that deserves the name of a principle. But how do chymists make it appear, that there are any such primitive and simple bodies as those we are speaking of, since 'tis confess'd, that these are not such? And if they pretend to prove this assertion by reason, what becomes of their confident boasts, that they can convince our eyes, by manifestly shewing, in any mix'd body, those simple substances they pretend them to be compos'd of?

It may, indeed, be plausibly represented in favour of the chymists, that, as 'tis evident much the greater part of any thing they call salt, sulphur, or mercury, is really such; it would be very rigid to deny those substances the names ascribed them, only because of some slight mixture of a different body. But since 'tis to experience that they appeal, we must not take it for granted, that the distill'd oil, for instance, of a plant, is chiefly compos'd of the pure principle call'd sulphur, till they have given us an ocular proof, that there is in that sort of plant such an homogeneous sulphur. For, as for the specious argument which is drawn from the resemblance betwixt the productions of the fire, and the respective *Aristotelian* elements, or chymical principles, by whose names they are called; the question is not, whether there be obtained from mixed bodies, certain substances, that agree in outward appearance, or in some qualities, with quick-silver, brimstone, &c. but, whether all bodies, confess'd to be perfectly mixed, were compos'd of, and are resolvable into a determinate number of primary, unmix'd bodies. It will not presently follow, that because a production of the fire has some affinity with the greater masses of matter here below, therefore they are of the same nature, and deserve the same name; for the chymists are not content, that flame should be look'd upon as a parcel of the element of fire, tho' it be hot, dry, and active; because it wants some other qualities belonging to the nature of elementary fire. Nor will they suffer the *Peripatetics* to call ashes, or quick-lime, earth, notwithstanding the great likeness between them; because they are not tasteless, as elementary earth ought to be: but if it be demanded, what it is that all the chymical analyses of bodies do prove, if they prove not that they consist of the three principles, into which the fire resolves them? I answer, that some mixed bodies, included in close vessels, are

are resolvable into several substances, different in some qualities, but principally in consistence; so that out of most of them may be obtained a fixed substance; partly saline, and partly insipid; an unctuous liquor, and another fluid, or more, that, without being unctuous, have a manifest taste. Now, if the chymists will agree to call the dry and sapid substance, salt; the unctuous liquor, sulphur; and the other, mercury; I shall not quarrel with them for it. But if they will tell me, that salt, sulphur, and mercury, are simple and primary substances, whereof each mixed body was actually compounded, and which were really in it antecedent to the operation of the fire; they must give me leave to doubt, whether their experiments prove all this. And if they will also tell me, the substances their analyses afford them, are pure and similar, as principles ought to be; they must give me leave to credit my own senses, and their own confessions, before their bare assertions. But as an element, or principle, ought to be perfectly similar and homogeneous; there is no just cause why I should rather give a body proposed, the name of any particular element or principle, because it has a resemblance to it in some obvious quality; rather than deny it that name, upon account of several other qualities wherein it is unlike.

The chymists will not allow to the *Aristotelians*, that the salt in ashes ought to be called earth; tho' the saline and terrestrial parts correspond in weight, in dryness, in fixedness, and fusibility; only because the one is sapid and dissoluble in water, and the other not: besides, we see that sapidness and volatility denominate the chymists mercury or spirit; and yet how many bodies may agree in those qualities, and still have very different natures, and numerous, disagreeing qualities? For, not only spirit of nitre, *Aqua fortis*, spirit of salt, oil of vitriol, spirit of alum, spirit of vinegar, and all saline liquors, distilled from animal bodies; but all the acetous spirits of woods, freed from their vinegar, and many others, must belong to the chymists mercury; tho' it appear not why some of them should rather be comprehended under one denomination, than the chymists sulphur or oil; for their distilled oils are also fluid, volatile, and sapid, as well as their mercury. Nor is it necessary that their sulphur should be unctuous, or dissoluble in water; since they generally refer spirit of wine to sulphurs; tho' that spirit be not unctuous, and will readily mix with water. So that bare inflammability must constitute the essence of the chymists sulphur; as the contrary, joined with any taste, entitles a distilled liquor to be their mercury. Now, since spirit of nitre, and spirit of hartshorn, will boil together, hiss, and throw up one another into the air; which the chymists make signs of great antipathies in the nature of bodies; since I have obtained two sorts of oil from the same parcel of human blood, that would not mix with one another; and since I have met with several examples of the contrariety of bodies, which, according to the chymists, must be huddled up together under

*That the chymical principles are dissimilar in their nature, shown in salts.*



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one denomination; I leave it to be consider'd, whether such a multitude of substances, as may agree in these slight qualities, and yet disagree in others more considerable, deserve to be call'd by the name of a principle; rather than to have such appellations, as may distinguish them in name, from the bodies they no way resemble in nature. And hence also, by the way, 'tis not unreasonable to distrust the chymists method of arguing; when, being unable to shew, that a liquor is, for example, purely saline, they prove, that, at least, salt is the predominant principle therein; because the proposed substance is strongly tasted, and all tast proceeds from salt; whereas those spirits, such as that of tartar, of hartshorn, and the like, which are reckoned to be the mercuries of the bodies that afford them, have manifestly a strong and piercing tast; as has the spirit of box, even after the acid liquor that concurr'd to compose it, hath been separated from it. And, indeed, if tast belong not to the spirit, or mercurial principle of vegetables, and animals, I scarce know how it will be distinguish'd from their phlegm; since by the absence of inflammability, it must be distinguish'd from their sulphur. And here again, we have another example of the inaccuracy of the chymical doctrine; since not only the spirits of vegetables and animals, but their oils, are very strongly tasted. Nay, a skilful and inquisitive person, who made it his business, by elaborate operations, to depurate chymical oils, and reduce them to an elementary simplicity, informs me, that he never was able to make them tasteless; whence I might infer, that the proof which chymists confidently give us, of a body's being saline, is so far from demonstrating the predominancy, that it does not clearly shew so much as the presence of the saline principle in it. Again; volatile salt of hartshorn, of amber, of blood, &c. are very strongly scented; notwithstanding that most chymists deduce odours from sulphur; and from them argue, the predominancy of that principle in the odorous body. These things being thus premis'd, we may the better observe, how dissimilar each of those bodies are, which the chymists call the salts, the sulphurs, or the mercuries of the bodies which yield them; as if they had all a natural simplicity, and identity of nature; whereas salts, for instance, if they were all elementary, would differ as little as the drops of pure and simple water. 'Tis known, that both chymists and physicians ascribe to the fix'd salts of calcined bodies, the virtues of their concretes; and, consequently, very different operations. So we find the alkali of wormwood, much commended in distempers of the stomach; that of eye-bright, in a weak sight; and that of guaiacum, in the venereal disease. And tho' I have long thought, that these alkaline salts are, for the most part, very nearly allied to each other; and retain very little of the properties of the concretes, whence they were separated; yet I have observed at the glass-house, that sometimes the metal proves of a very different colour, and a somewhat different

different texture; which the most skilful workmen impute to the ashes of some certain kind of wood; as having observed the baser sort of glass to be frequently produc'd, when they had employed such ashes; which, therefore, they scruple to make use of, if they know it. I remember, also, that an industrious man of my acquaintance, having bought a vast quantity of tobacco-stalks, to make a fix'd salt with, I went to see, whether that plant, which so much abounds in volatile salt, would afford a peculiar kind of alkali; and found, that in the lixivium thereof, it was not necessary to evaporate all the liquor as usual; but the fixed salt shot into figured crystals, almost as nitre, or sal-armoniac, and other uncalcin'd salts usually do. And fixed salt of urine, brought by depuration to be very white, I have perceived it tast not unlike to that of common salt, and very different from the general caustic, lixivate tastes of other salts, made by incineration. However, I am still inclined to think, that most chymists, and many physicians, inconsiderately, and without warrant from experience, ascribe the virtues of the concretes, exposed to calcination, to the salts thereby obtained. And, therefore, to shew the disparity of salts, I shall observe the apparent difference betwixt the vegetable fixed salts, and the animal, volatile ones; as, for example, betwixt salt of tartar, and salt of hartshorn; whereof the former is so fixed, that it will endure a violent fire, and stand in fusion, like a metal; whilst the other will fly away in a gentle heat, as easily as spirit of wine. And even among the volatile salts, there is a considerable difference; as appears by the distinct properties of salt of amber, for instance, salt of urine, salt of man's skull, &c. And this diversity of volatile salts, is sometimes discernible, even to the eye, in their figure. For the salt of hartshorn will adhere to the receiver, in the form almost of a parallelopiped; and of the volatile salt of human blood, I have seen many grains of a rhomboidal figure; tho' I dare not undertake, that the figures of those, or other saline crystals, will be always the same, whatever degree of fire is employed to force them up; or how hastily soever they have been made to convene in the liquor; in the lower part of which I have usually observ'd them, after a while, to shoot. And tho', as I lately said, I seldom found any difference, as to medical virtues, in the fixed salts of several vegetables, they having generally agreed, in being diaphoretic and deobstruent; yet *Helmont* informs us, that there is this difference betwixt the saline spirit of urine, and that of human blood, that the former will not cure the epilepsy, as the latter will. Of the efficacy also, of the salt of common amber, against the same disease in children, I have seen instances. And when I consider, that to obtain these volatile salts, there is not requisite such a destructive violence of the fire, as to produce those salts made by incineration; I am the more ready to conclude, that they may differ from one another, and, consequently, recede from an elementary simpli-

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city. And I have found such various chymical distinctions of salts, that I cannot but say, the chymists give themselves a strange liberty, to call concretes by that name; which, according to their own rules, are to be look'd upon as very compounded bodies; so that among those very salts which seem elementary, because produced upon the analysis of the bodies that yield them, there is not only a visible disparity, but a manifest contrariety; as is evident in the ebullition and hissing that ensue, when the acid spirit of vitriol, for instance, is poured upon pot-ashes, or salt of tartar. And not only the same body may have two salts of a contrary nature, as happens in the spirit and alkali of nitre; but from it there may, without addition, be obtained three different, visible salts. For in urine there is a volatile and crystalline salt, a fixed salt, and a kind of sal-armoniac, or such a salt as will sublime in the form of a salt; and therefore is not fixed, tho' far from being so fugitive as the volatile salt, from which it seemed also otherwise to differ. I have, indeed, suspected, that this may be a proper sal-armoniac, compounded of the volatile salt of urine, and the fixed one of the same liquor. And for an ocular proof of the difference betwixt the fixed and volatile salt of wood, I devised the following experiment. I took a strong solution of common *Venetian* sublimate, made in fair water, and a clear lixivium of wood ashes; then, on one part of the former solution, dropping a little of the latter, the liquors presently turned of an orange colour; but to another part of the clear solution of sublimate, putting some of the volatile salt of wood; the liquor immediately turned white, almost like milk; and, after a while, let fall a white sediment, as the other did a yellow one.

*In sulphurs  
or chymical  
oils.*

This disparity is, also, very remarkable in the separated sulphurs, or chymical oils of things. For they contain so much of the scent, taste, and virtues of the bodies whence they were drawn, that they seem to be but the material frame of their concretes. Thus the oils of cinnamon, cloves, &c. appear to be but the united aromatic parts of those bodies. And 'tis a known thing, that oil of cinnamon, and oil of cloves, with that of several woods, will sink to the bottom of water; whilst those of nutmegs, and several other vegetables, swim upon it. Oil of roses swims at the top of water, in the form of a white butter; which I remember not to have observed in any other oil, drawn in an alembic; yet there is a way by which I have seen it surprizingly brought over, in the form of other aromatic oils. In oil of aniseeds, which I drew both with and without fermentation, I observed the whole body of the oil, in a cool place, to thicken into the consistence and appearance of white butter; which, with the least heat, resumed its former liquidity. In the oil of olive, drawn over in a retort, I have, likewise, more than once seen, a spontaneous coagulation in the receiver; and thus congeald, it has a strangely penetrating scent, as if it would perforate the nose that approached it.

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The like pungent odour I also observ'd in the distill'd liquor of common sope, which, forced over from *minium*, has afforded an oil most admirably piercing. And he must be a great stranger, both to the writings and preparations of chymists, who sees not in the oils, they distil from vegetables and animals, a considerable and obvious difference. Nay, from the same animal or vegetable, there may often be extracted oils of natures greatly different.

I took a pound of aniseeds, grossly bruised, and caus'd them to be put into a very large glass retort, almost fill'd with fair water; and placing this retort in a sand furnace, a very gentle heat was administered, during the first day, and a great part of the second, till the water coming over, had brought with it most of the volatile and aromatic oil of the seeds; then, increasing the fire, and changing the receiver, I obtain'd, besides an empyreumatical spirit, a quantity of adust oil, whereof a little floated upon the spirit; but the rest was more heavy, and not easily separable from it. And tho' these oils were very dark, and smell'd so strongly of the fire, that their odour did not betray from what vegetable they had been forc'd; the other aromatic oil was enrich'd with the genuine smell and tast of the concrete, and spontaneously coagulated into a white butter. There is another sort of bodies, which, tho' not obtain'd by distillation, many chymists call sulphur; being, for the most part, high colour'd, as dissolv'd sulphurs usually are: but especially, because they are generally abstracted and separated from the rest of the mass by spirit of wine; which liquor, those men supposing to be sulphureous, they conclude, that what it works upon and abstracts, must be a sulphur also. And upon this account, they presume that they can separate the sulphur even of minerals and metals; from which, 'tis known, they cannot, by fire alone, obtain it. But if these sequestred substances, were indeed the sulphurs of the bodies whence they are drawn, there would as well be a great disparity betwixt chymical sulphurs, obtain'd by spirit of wine, as I have already shewn there is betwixt those, obtain'd by distillation, in the form of oils; for 'tis plain, that in tinctures, drawn from vegetables, if the superfluous spirit of wine be distill'd off, it leaves at the bottom the thicker substance, which chymists call the extract of the vegetable. And that these extracts are endow'd with very different qualities, according to the nature of the particular bodies that afforded them, is freely confess'd both by physicians and chymists.

And here too, we may take notice, that the chymists, in this case, as in many others, allow themselves to abuse words; for not again to argue from the different properties of tinctures, that they are not exactly pure and elementary sulphurs; they would easily appear not to be so much as sulphurs; altho' we should allow chymical oils to deserve that name. For, however in some mineral tinctures, the natural fixedness of the body extracted, does not always suffer it, to be, with ease, further resolvable into different substances; yet in very many extracts,

*Chymistry.* tracts, drawn from vegetables, it may very easily be manifested, that the spirit of wine has not sequestred the sulphureous ingredient from the saline and mercurial ones; but dissolv'd the finer parts of the concrete, and united it self with them into a kind of magistery; which therefore must contain ingredients, or parts of several sorts: for we see, that the stones which are rich in vitriol, being often drench'd with rain water, yield thereto a fine transparent substance, coagulable into vitriol; and yet, tho' this vitriol be readily dissoluble in water, it is not a true elementary salt, but a body resolvable into very different parts, whereof one is yet of a metalline, and consequently not of an elementary nature. We may consider also, that common sulphur is readily dissoluble in oil of turpentine, tho' it abounds as well in salt as in true sulphur; witness the great quantity of saline liquor it affords, when set to flame away under a glass bell. Nay, I have with the same oil of turpentine alone, easily dissolv'd crude antimony, finely powder'd, into a blood red balsam, wherewith, perhaps, considerable things may be perform'd in surgery. And 'tis not unlikely, that spirit of wine, which, by its pungent taste, and some other qualities, especially its being reducible, according to *Helmont*, into alkali and water, seems to be as well of a saline, as of a sulphureous nature, may well be suppos'd capable of dissolving substances that are not meerly elementary sulphurs, tho' perhaps they abound with parts of kin thereto. For I find that spirit of wine will dissolve *Gum. Lacca*, benjamin, and the resinous parts of jalap, and even of guaiacum; whence we may well suspect, that it may from spices, herbs, and other less compact vegetables, extract not perfect sulphurs, but mix'd bodies. And to put this past dispute, there is many a vulgar extract drawn with spirit of wine, which committed to distillation, will afford such different substances, as loudly proclaim it to have been a very compounded body. Hence we may justly suspect, that even in mineral tinctures, it will not always follow, that because a red substance may be drawn from a concrete, by spirit of wine, that substance is its true and elementary sulphur. And tho' some of these extracts may, perhaps, be inflammable, yet besides that others are not; and besides that their being reduced to such minuteness of parts, may much facilitate their taking fire; we see that common sulphur, common oil, gum lac, with many unctuous and resinous bodies, will flame, tho' they be of a very compounded nature: nay, travellers, of unsuspected credit, assure us, as a known thing, that in some northern countries, where fir-trees and pines abound, the poorer sort of inhabitants use long splinters, of those resinous woods, to burn, instead of candles. And as for the redness to be met with in such solutions, I could easily shew, that 'tis not necessary it should proceed from the sulphur of the concrete, dissolv'd by the spirit of wine; by declaring how much chymists delude themselves and others, thro' ignorance of those other causes, whereby spirit of wine, and other menstrua, may acquire

acquire a red or some high colour. But to return to our chymical *Chymist-y.* oils; supposing they were exactly pure, I hope they would only be, as the best spirit of wine is, the more inflammable and deflagrable. And therefore, since an oil may be, by the fire alone, immediately turn'd into flame, I demand how this can be a primogeneal and incorruptible body; as chymists would have their principles; since it is further resolvable into flame? Which whether or no it be a portion of the element of fire, as an *Aristotelian* would conclude, is certainly something of a very different nature from a chymical oil; since it burns, and shines, and mounts swiftly upwards; which are not the properties of a chymical oil, whilst it continues in its natural state. If it be objected, that the dissipated parts of this flaming oil, may be collected again into oil or sulphur, I ask, what chymist has ever done it? And without examining whether it may not hence be as well concluded, that sulphur is but compacted fire, as that fire is but diffus'd sulphur; I leave it to be considered, whether it may not hence be argued, that neither fire, nor sulphur, are primitive, undestructible bodies; and observe, that, at least, it hence appears, that a portion of matter may, without being compounded with new ingredients; by having the texture and motion of its small parts changed, be easily, by the means of fire, endow'd with new qualities, more different from what it had before, than are those which suffice to discriminate the chymists principles from one another.

We are next to consider, whether in the analysis of mix'd bodies, that which chymists call the mercurial part of them, be uncompound- *Id. mercurius, or spiritus* ed or no. But tho' chymists unanimously affirm, that their resolutions discover a principle, which they call mercury; yet I find them to give such different and enigmatical descriptions of it, that I know not what to make of them. *Paracelsus*, and many of his followers, call that mercury, which ascends upon the burning of wood; as the *Peripatetics* take the same smoke for air; and so seem to define mercury by volatility. But since, in this example, both volatile salt and sulphur make part of the smoke, which does, indeed, consist both of phlegmatic and terrestrial corpuscles, this notion is not to be admitted. And I find that the more sober chymists themselves disavow it. Yet to let us see how little clearness we are to expect in the chymists, *Beguinus*, even in his *Tyrocinium chymicum*, written for the instruction of novices, defines mercury thus. "Mercury," says he, "is that acid, permeable, penetrable, ethereal, and most pure spirit; from whence proceeds all nutriment, sense, motion, strength, heat, and prolongation of juvenile years." Which words are not so much a definition of it, as an encomium; and yet *Quercetan*, in his description of the same principle, adds to these, several other epithets. But both of them speak inconsistently with the chymical principles. For, if mercury be an acid liquor, either the hermetical philosophy must err in ascribing all taste to salt; or else mercury must not be a principle, but compounded.



*Chymistry.* pounded of a saline ingredient, and somewhat else. *Libavius*, tho' he finds great fault with the obscurity of what the chymists write, concerning their mercurial principle; yet gives us such a negative description of it, as *Sennertus*, how favourable soever to the *tria prima*, is not satisfied with. And this *Sennertus* himself, tho' the learnedst champion for the hypostatical principles, frequently complains of the unsatisfactoriness of what the chymists teach concerning their mercury, substitutes, instead of the description of *Libavius*, another, which many readers know not what to make of.

But since the mercurial principle, that arises from distillation, is unanimously asserted to be distinct from the salt and sulphur of the same concrete; perhaps that may be called the mercury of a body, which, tho' it ascend in distillation, as the phlegm and sulphur, is neither insipid, like the former, nor inflammable like the latter; and therefore may be term'd spirit; which is now very much made use of, even by the chymists of our times; tho' they have not distinctly told us what may properly be call'd the spirit of a mix'd body.

However, what the vulgar chymists mean by the mercury of animals and vegetables, consistently with their own principles, will not be so easie to find; for they ascribe taste only to the saline principle, and consequently wou'd be much put to it, to shew what liquor it is, in the resolution of bodies, that not being insipid, is neither inflammable, as oil or sulphur, nor has any taste. And if we shou'd take spirit in the sense of the word receiv'd among modern chymists and physicians, for any distill'd liquor, that is neither phlegm nor oil; the appellation wou'd yet appear ambiguous. For, plainly, that which first ascends in the distillation of wine, and fermented liquors, is generally, as well by chymists as others, reputed a spirit: and yet, pure spirit of wine being wholly inflammable, ought, according to them, to be reckon'd the sulphureous, not the mercurial principle. And among the other liquors, that pass under the name of spirits, there are several which seem to belong to the family of salts; such are the spirits of nitre, vitriol, sea-salt, &c. And even the spirit of hartshorn, being, as I have try'd, in great part, if not totally, reducible into salt and phlegm, may be suspected to be but a volatile salt, disguised by the phlegm mix'd with it, in the form of a liquor. But if this be a spirit, it manifestly differs very much from that of vinegar; the taste of the one being acid, and the other salt; and the mixture of them, in case they be very pure, sometimes occasioning a strong effervescence. And even among such liquors as seem to have a better title than those hitherto mentioned, to the name of spirits, there appears a sensible diversity: thus spirit of oak, for instance, differs from that of tartar; and this from that of box, or guaiacum. And, in short, even these spirits, as well as other distill'd liquors, manifest a great disparity betwixt themselves, either in their actions on our senses, or in their other operations.

And

And besides this disparity, to be met with among those liquors, which the moderns call spirits, and take for similar bodies; what I formerly said, concerning the spirit of box-wood, may shew, that some of those liquors, not only have qualities very different from others; but may be further resolv'd into substances different from each other.

And since many modern chymists, and other naturalists, take the mercurial spirit of bodies for the same principle, under different names; I must observe, that there is a great difference, conspicuous, betwixt all the vegetable and animal spirits I have mention'd, and the purest running mercury, separated from metals; which, by some chymists, that seem more philosophers than the rest, for distinction sake, call *Mercurius corporum*. Now this metalline liquor being one of those three principles, of which mineral bodies are affirm'd to be compos'd, and to be resolvable into; the many notorious differences betwixt them and the mercuries, as they call them, of vegetables and animals, will allow me to infer, either that minerals, and the two other sorts of mix'd bodies, consist not of the same elements; or that those principles, whereinto minerals are immediately resolv'd, which chymists, with great ostentation, shew us, as the true principles of them, are but secondary principles, or mix'd bodies of a peculiar sort, which must be themselves reduced to a very different form, to be of the same kind with vegetable and animal liquors.

But this is not all; for tho' I formerly shew'd how little credit is to be given to the common chymical processes of extracting the mercuries of metals; I will now add, that supposing the more judicious artists truly affirm, they have actually drawn true and running mercury from several metals; it may be doubted whether such mercuries do not as well differ from common quick-silver, and from one another, as from the mercuries of vegetables and animals. *Claveus* speaking of some experiments, whereby metalline mercuries may be fix'd into the nobler metals, \* adds, that he means the mercuries drawn from metals; because common quick-silver, by reason of its excessive coldness and moisture, is unfit for that particular kind of operation, wherein, tho' a few lines before he prescribes, in general, the mercuries of metalline bodies, yet he chiefly commends that drawn, by art, from silver. And he, also, tells us, he himself try'd, that, by bare coction, the quick-silver of tin, or pewter, may, by an efficient cause, be turned into pure gold †. And the experienc'd *Alexander van Suchten* says,

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that

\* According to M. *Homburg*, a perfect metal is nothing but very pure mercury, whose small particles are every way pierced and filled with his sulphureous principle, or the matter of light, which links and binds the whole mass together. See *French Memoirs*, A. 1705. p. 122.

† Gold, according to M. *Homburg*, differs from silver in nothing but in having the globules of the mercury, whereof it consists, penetrated through and through; and being more fully saturated with the sulphureous principle, or the rays of light, which more plentifully lodge themselves

in

Chymistry

that by a way he intimates, may be made a mercury of copper, not of the silver colour of other mercuries, but green. And an eminent person lately assured me, that he had more than once seen the mercury of lead fix'd into perfect gold. And asking him, whether any other mercury wou'd not have been so chang'd by the same operations, he assured me it wou'd not.

The sulphur of antimony, which is vehemently emetic, and the strongly scented anodyne sulphur of vitriol, incline me to think, that not only mineral sulphurs differ from vegetable ones, but also from one another; retaining much of the nature of their concretes. And *Paracelsus*, in some part of his works, declares, that different bodies afford different sulphurs, salts, and mercuries.

And also in  
phlegm and  
earth.

'Tis also observable, that those bodies which chymists call phlegm and earth, are far from being of an elementary simplicity. Thus we see, the phlegm of vitriol, for instance, is a very effectual remedy against burns; and I know a very famous and experienc'd physician, whose unsuspected secret it is for discussing hard and obstinate tumors. The phlegm of vinegar, tho' drawn exceeding leisurely in a digesting furnace, I have purposely made tryal of; and, sometimes, found it able to extract a saccharine sweetness out of lead; and, as I remember, by long digestion, I dissolved corals in it. The phlegm of the sugar of lead is said to have very peculiar properties: many eminent chymists teach that it will dissolve pearls, which being precipitated by the spirit of the same concrete, are thereby, they say, render'd volatile: and this has been confirm'd to me by the observation of a person of great veracity. The phlegm of wine, and indeed of several other liquors that are indiscriminately cast away as phlegm, have qualities that make them differ, both from meer water, and from each other and tho' the chymists call the *Caput mortuum*: of what they have distill'd, *terra damnata*; it may be question'd, whether or no those earths are, all of them, perfectly alike; and it is scarce to be doubted but that there are some of them which remain yet unreduced to no elementary nature. The ashes of wood, deprived of all the salt, and bone-ashes, or calcin'd harts-horn, which refiners chuse to make tests of, as freest from salt, seem unlike; and he who shall compare either of these insipid ashes to lime, and to the calx of talc, will, perhaps, see cause to think them of a different nature. And it is evident in colcothar, that the exactest calcination, follow'd by an exquisite dulcification, does not always reduce the remaining body into elementary earth; for after the salt or vitriol is drawn out, the remainder appears to be a mix'd body, rich in medical virtues;

in its pores, than in the pores of silver; and from hence he supposes gold receives its yellow colour, and excess of gravity. And proceeding upon this supposition, he

actually produced gold by introducing a large quantity of fire, or the rays of light, into silver. See *French Memoirs*, A. 1709. p. 139—143.



as experience has inform'd me: and *Angelus Sala* affirms it to be partly reducible into malleable copper, which to me seems very probable; for having put some dulcified colcothar into *Aqua fortis*, I found the liquor, according to my expectation, presently colour'd as highly, as if it had been an ordinary solution of copper.

Chymistry.

S E C T. V.

I Think I have sufficiently prov'd, that those distinct substances, which chymists obtain from mix'd bodies, by their vulgar distillation, are not pure and simple enough, to deserve the name of principles, or elements. But I know, there are some modern chymists, who pretend they can, by further and more skilful purifications, so reduce the separated ingredients of mix'd bodies to an elementary simplicity; that the oils, for instance, extracted from all mix'd bodies, shall as perfectly resemble one another as the drops of water.

Whether the five principles shou'd be reject-ed for not being homogeneous?

Now this seems to allow what I have been contending for; since by pretending to make so great a change, in the reputed principles that distillation commonly affords, 'tis plainly presuppos'd, that before such artificial depurations are made, the substances to be render'd more simple, were not simple enough before, to be reckon'd elementary; and therefore, if some artists can perform this, I need not be ashamed to have question'd the vulgar opinion, as to the *tria prima*. But as to the thing it self, I shall not peremptorily deny either its possibility, or refuse my assent to any just inference, that may be drawn from such performances. But because such promises are much more easily made, than perform'd, by chymists; I must withhold my assent to their assertions, till their experiments exact it. Besides, I have not yet found, tho' these artists pretend to bring the several substances, into which the fire has divided the concrete, to an exquisite simplicity, that they pretend also, by the fire, to divide all concretes, minerals, and others, into the same number of distinct substances. In the mean time, I must think it improbable, that they can either truly separate as many different bodies, from gold, for instance, or osteocolla, as we can do from wine or vitriol; or, that the mercury of gold, or lead, would be perfectly of the same nature with that of hartshorn; and that the sulphur of antimony would be but numerically different from the distill'd butter or oil of roses.

But suppose we should take earth and water into the number of the principles of mix'd bodies, and changing the ambiguous name of mercury, for that more intelligible one of spirit, should, consequently, make the principles of compound bodies to be five; wou'd it not be too severe to reject so plausible an opinion, only because the five sub-

*Chymistry.* stances, into which the fire divides mix'd bodies, are not exactly pure and homogeneous?

Whence the  
notion of five  
chymical prin-  
ciples?

Of this opinion I shall only say in general, that tho' I think it, in some respects, more defensible than that of the vulgar chymists; yet it may easily appear, that many of the objections, produced against the vulgar doctrine of chymists, might, without much alteration, be employ'd against this also. For this doctrine, as well as the other, takes it for granted, that the fire is the true and adequate analyzer of bodies; and that all the distinct substances, obtainable from a mix'd body by the fire, were so pre-existent in it, that they were but extricated from each other by the analysis. This hypothesis too, ascribes to the productions of the fire an elementary simplicity, which I have shewn not to belong to them; and besides, is liable to some of the other difficulties, wherewith that of the *tria prima* is incumber'd. But farther, this number of elements ought, at least, to have been restrained to the generality of animal and vegetable bodies; since not only among these, there are some, for ought has hitherto appear'd, that consist either of fewer similar substances, or more than five. But in the mineral kingdom, there is scarce one concrete, that has been shewn to be adequately divisible into five such principles, or elements, neither more nor less, as this opinion would have every mix'd body to consist of. And this very thing may serve to lessen our wonder, that just so many bodies as five, should be found upon the resolution of concretes. For since the fire cannot, as we find, make any such analysis of metals, and other mineral bodies, whose texture is more strong and permanent; it remains, that the five substances, under consideration, be obtain'd from such vegetable and animal bodies, as are capable of being distill'd. And as to such bodies, 'tis natural enough, that whether we suppose there are or are not precisely five elements; there should ordinarily occur five distinct sorts of separated parts. For if the parts do not remain all fix'd, as in gold, calcin'd talc, &c. nor all ascend, as in the sublimation of brimstone, camphire, &c. but after their dissipation, associate themselves into new arrangements of matter; it is very likely, that they will, by the fire, be divided into fix'd and volatile; with regard to that degree of heat by which they are distill'd; and those volatile parts will, for the most part, ascend either in a dry form, which chymists, if they be tasteless, call flowers, and if sapid, volatile salt; or in a liquid form. And this liquor must be either inflammable, and so pass for oil, or not inflammable, and yet subtil and pungent, which may be call'd spirit; or else strengthless or insipid, and so term'd phlegm or water. And as for the fix'd part, or *Caput mortuum*, it will most commonly consist of corpuscles, partly soluble in water, or sapid, which makes up its fix'd salt; and partly insoluble and insipid, which, therefore, seem to challenge the name of earth. But tho', upon this supposition, we might easily have foretold, that the different substances, obtain'd from a perfectly mix'd body,

body, by the fire, would generally be reducible to these states of matter; yet it will not presently follow, that these five distinct substances were simple and primogeneal bodies, so pre-existent in the concrete, that the fire does but take them asunder. Besides, it does not appear, that all mix'd bodies, nay, nor perhaps all vegetables, are resolvable by fire, into just such different parts of matter. Nor will the experiments formerly alledg'd, permit us to look upon these separated substances, as elementary or uncompounded. It is not a sufficient argument, of their deserving the names which chymists give them, that they have an analogy in point of consistence, volatility, fixedness, or some other obvious quality, to the supposed principles whose names they bear. For, as we said above, notwithstanding this resemblance in some one quality, there may be such a disparity in others, as should rather give them different appellations, than the resemblance entitle them to the same. And indeed, it seems but a gross way of judging of the nature of bodies, to conclude, without scruple, that those must be of the same nature, that agree in some general quality, as fluidity, dryness, volatility, and the like; since each of those qualities, or states of matter, may comprehend a great variety of bodies, otherwise of a very different nature; as we see in the calxes of gold, of vitriol, and of *Venetian* talc, compared with common ashes; which yet are very dry, and fix'd by the vehemence of the fire, as well as they. The same also appears from what I formerly observ'd as to the spirit of box-wood; which, tho' a volatile, sapid, and not inflammable liquor, as well as the spirits of harts-horn, of blood, and other things, may yet be sub-divided into two liquors, different from each other, and one of them, at least, from the generality of other chymical spirits.

'Tis farther urg'd, in behalf of five chymical principles, that so many appear absolutely necessary to compound mixed bodies, and to give them a due consistence, and competent duration. For salt, say the patrons of this opinion, is the basis of solidity and permanency, in compound bodies; without which the other four elements might, indeed, be variously and loosely blended together, but would remain incompact; but that salt might be dissolv'd into minute parts, and convey'd to the other substances to be compacted by it, and with it, there is a necessity of water. And that the mixture may not be too hard and brittle, a sulphureous, or oily principle, must intervene, to make the mass more tenacious: to this a mercurial spirit must be super-added; which, by its activity, may, for a while, permeate, and, as it were, leaven the whole mass; and thereby promote the more exquisite mixture, and incorporation of the ingredients. To all these, a portion of earth must be join'd; which, by its dryness and porosity, may soak up part of that water, wherein the salt was dissolv'd; and eminently concur, with the other ingredients, to give the whole body the requisite consistence. This opinion I shall not

now

*Whether five  
be necessary in  
the composition  
of bodies?*



*Chymistry.*

now thoroughly examine; only observe, that such a way of arguing may be speciously accommodated to different hypotheses. For I find, that *Beguinus*, and other assertors of the *tria prima*, pretend to make out by it, the necessity of their salt, sulphur, and mercury, to constitute mixed bodies; without requiring any addition of water and earth.

And, indeed, neither sort of chymists seem to have duly consider'd, how great a variety there is in the textures and consistences of compound bodies; and how little the consistence and duration of many of them seem to agree with their notions. And, not to mention those almost incorruptible substances obtainable by fire, which I have prov'd to be somewhat compounded; and which the chymists will readily grant not to be perfectly mixed bodies; I have shewn by experiments, that out of common water only, mixed bodies of very different consistences, and resolvable by fire, into as many principles as other bodies, acknowledged to be perfectly mixed, may be produced. And therefore nature, by a convenient disposition of the minute parts of a portion of matter, may contrive bodies durable enough, and of any consistence, without being obliged to make use of all, much less of any determinate quantity of each of the five elements, or of the three principles, in their composition. And I have wonder'd chymists should not consider, that there is scarce any body in nature so permanent and indissoluble as glass; which yet themselves teach us may be made of bare ashes, brought to fusion by the meer violence of the fire. So that, since ashes are granted to consist but of pure salt, and simple earth, sequestred from all the other principles, or elements; they must acknowledge, that even art it self can, of two elements only, or of one principle, and one element, compound a body more durable than almost any in the world. How, then, will they prove, that nature cannot compound mixed bodies, and even durable ones, with fewer than all the five elements, or material principles?

Since, then, it may justly be doubted, whether the fire be the genuine and universal resolver of mixed bodies; since we may doubt, whether all the distinct substances, obtainable from a mixed body by the fire, were pre-existent therein, under those forms wherein they are separated from it; since, tho' we grant the substances, separable from mixed bodies by the fire, to have been their component ingredients, yet the number of such substances does not appear the same in all mixed bodies; since, lastly, those very substances thus separated, are not generally pure and elementary, but new kinds of mixed bodies; we must be allowed to say, that the vulgar experiments and arguments, alledged by chymists, to prove that their three hypostatical principles, adequately compose all mixed bodies, will not induce a wary person to acquiesce in their doctrine.

And

Chymistry.

The imperfections of the chymical doctrine of three principles.

And hence we learn what to judge of those chymists, who, because they have found several compound bodies may be resolved into, or rather be brought to afford two or three different substances, more than the foot and ashes, into which the naked fire commonly divides them, cry up their own sect for the invention of a new philosophy; some styling themselves philosophers by the fire; and the major part not only ascribing, but, as far as in them lies, engrossing to those of their sect the title of philosophers.

But, alas! how narrow is this philosophy, that reaches but to some of those compound bodies, which we find upon the surface, or crust of our terrestrial globe; which is it self but a point, in comparison of the vast extended universe, of whose other and greater parts, the doctrine of the *tria prima* gives us no account? For what does it teach us either of the nature of the sun, or of that of the fixed stars? What does knowing that salt, sulphur, and mercury, are the principles of mixed bodies, inform us of the nature of that vast fluid, and ethereal substance, which seems to make up the interstellar part of the world?

We might, however, forgive this hypothesis, if, tho' it reaches but to a very small part of the world, it gave us a satisfactory account of those things, whereto 'tis said to extend. But I find not that it gives any other than a very imperfect information, even about mixed bodies themselves. For how will the knowledge of the *tria prima*, discover the reason, why the load-stone draws a needle, and disposes it to respect the poles, and yet seldom to point precisely to them? How will this hypothesis teach us, the manner wherein a chick is formed in the egg; or how the seminal principles of mint, pompions, and other vegetables, that I formerly mentioned, can fashion water into various plants, each endowed with its peculiar and determinate shape, and with several specific and discriminating qualities? Does this hypothesis shew us, how much salt, how much sulphur, and how much mercury, must be taken in, to make a chick, or a pompion? And, if we know this, what principle is it that manages these ingredients, and contrives such liquors, for instance, as the white and yolk of an egg, into such a variety of textures, as is requisite to form the bones, veins, arteries, tendons, nerves, feathers, blood, &c. of a chick; and not only to fashion each limb, but to connect them altogether, after a manner suitable to the perfection of the animal? For to say, that some more fine and subtle part of the hypostatical principles, is the director in this whole affair, and the architect of all this elaborate structure; is to give occasion to demand again, what proportion, and way of uniting of the *tria prima*, afforded this architectonic spirit; and what agent made so skilful and happy a mixture? I could easily prosecute the imperfections of the vulgar chymical philosophy; and shew, that by attempting, from their three principles, to explain even such obvious and familiar phenomena, as fluidity and firmness, the

*Chymistry.*

the colours and figures of stones, minerals, and other compound bodies, the nutrition of either plants, or animals, the gravity of gold, or quick-silver, compared with wine, or spirit of wine, &c. from any proportion of the three simple ingredients, chymists will be much more likely to discredit themselves and their hypothesis, than to satisfy an intelligent enquirer.

This objection, 'tis true, may be made to the four *Peripatetic* elements also; and, indeed, almost to any other hypothesis, that pretends, by a determinate number of material ingredients, to solve the phenomena of nature. But for the use of the *tria prima*, I know their great champion *Sennertus*, assigns this noble advantage thereto; that from them, as the nearest and most proper principles, may be demonstrated the properties of mixed bodies; which cannot be immediately deduced from the elements. And this, says he, is chiefly apparent, when we enquire into the properties and faculties of medicines.

And, indeed, if the chymists had been so modest, or so discreet, as to propose their opinion of the *tria prima*, barely as a notion useful, among others, to increase human knowledge, they had deserved more thanks, and less opposition; but since the thing they pretend to is not so much to contribute a notion towards the improvement of philosophy, as to make this notion pass for a new system, that will clear and remove all difficulties; 'tis proper they should be made sensible of their mistake, and be advis'd to take in more fruitful and comprehensive principles, if they mean to account for the phenomena of nature.

But when I acknowledge the labours of the chymists useful to natural philosophy, I do it upon account of their experiments, not their speculations; for it seems to me, that their writings, like their furnaces, afford smoke, as well as light; and darken some subjects, as they illustrate others. And tho' 'tis difficult for a man to be an accomplish'd naturalist, who is a stranger to chymistry; yet I look upon the common operations and practices of chymists, as on the letters of the alphabet, without the knowledge whereof 'tis very hard to become a philosopher; tho' that knowledge is, by no means, sufficient to make one.

*With the advantages thereof, consider'd.*

But to consider the doctrine of the *tria prima* a little more particularly; I shall readily acknowledge it has done the common-wealth of learning some service, by helping to destroy that excessive esteem, or veneration, wherewith the doctrine of the four elements was generally entertained; tho' what has been alledg'd concerning the usefulness of these principles, labours under considerable difficulties.

And, first, the very way of arguing, used by the more learned and sober champions of the chymical cause, to prove the chymical principles in mixed bodies, appears far from convincing. *Sennertus* tells us, that the most learned philosophers thus prove the most important points in philosophy. "Wherever," says he, "the same properties



“perties and qualities are found, they must necessarily exist by some *Chymistry*.  
 “common principle; thus things are heavy by reason of the earth;  
 “and hot, by reason of the fire they contain; but colours, odours,  
 “tasts, inflammability, &c. are found in minerals, metals, gems,  
 “stones, plants, and animals, where they consequently reside by some  
 “common principle: but the elements are not this principle, for  
 “they have no power to produce them; we must, therefore, enquire  
 “for other principles from whence they proceed.”

But this argument is built upon a precarious supposition, that seems to me neither demonstrable, nor true; for how does it appear, that where the same quality is to be met with in bodies, it must belong to them upon the account of some one body whereof they all partake? For, to begin with that very example he alledges, how can he prove, that the gravity of all bodies proceeds from participating of the element of earth; since we see, that not only common water, but the most pure distill'd rain water, is heavy; and quicksilver much heavier than earth it self? And I the rather use this example of quick-silver, because I see not how the assertors of the elements, will give any better account of it, than the chymists. For if we demand, how it comes to be fluid; they will answer, that it greatly participates of the nature of water. And, indeed, according to them, water may be the predominant element in it; since we see that several bodies, which by distillation afford liquors more, in weight, than their *Caput mortuum*, have not, however, liquor enough to be fluid. Yet if it be demanded, how quick-silver comes to be so heavy; 'tis reply'd, by reason of the earth that abounds in it. But since, according to them, it must consist of air, and partly of fire, which they affirm to be light elements; how comes it to be so much heavier than earth of the same bulk; tho', to fill the cavities, it be made into a mass with water, which, it self, they allow, to be a heavy element? But we see, that chymical oils and fixed salts, tho' never, so exquisitely purified, and freed from terrestrial parts, remain ponderous. And experience has informed me, that a pound of the heaviest woods, as guaiacum, that will sink in water, will yield, when burnt to ashes, a much less weight of them than lighter vegetables; as also, that the black charcoal of it will not sink, as did the wood, but swim: which argues, that the different gravity of bodies proceeds chiefly from their particular texture; as is manifest in gold, the closest and most compact of bodies; which is many times heavier than we can possibly make any parcel of earth of the same bulk. I will not examine what may be argued from the gravity of the celestial bodies, from the motion of the spots in the sun, and from the apparent equality of the suppos'd seas in the moon; nor consider how little those phenomena would agree with what *Scnnertus* presumes concerning it: but to invalidate his supposition, I demand, upon what chymical principle fluidity depends? And yet fluidity

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is, perhaps, two or three excepted, the most diffused quality of the universe; and far more general than almost any of those to be met with in the chymical principles, or *Aristotelian* elements; since not only the air, but that vast expanse we call heaven; and perhaps too the sun, and fixed stars, are fluid bodies. I demand also, from which of the chymical principles motion proceeds; which yet is a property of matter much more general than can be deduced from any of the three chymical principles? I might ask the like question concerning light; which is not only to be found in the kindled sulphur of mixed bodies, but in living glow-worms, &c. and in the vast bodies of the sun and stars. I would also gladly know, in which of the three principles, the quality we call sound resides, as in its proper subject; since either oil falling upon oil, or spirit upon spirit, or salt upon salt, in a great quantity, and from a considerable height, will create it; and to make the objection reach the *Aristotelians*, water upon water, and earth upon earth. And here let us compare, a little, the supposition we are examining, with some other of their tenets. They teach, in effect, that more than one quality may belong to, and be deduced from one principle: for they ascribe to salt taste, and the power of coagulation; to sulphur, odours and inflammability; and some of them ascribe to mercury colours; as all of them do the property of vanishing in fume. On the other side, it is evident, that volatility belongs, in common, to all the three principles, and to water too. For 'tis manifest, that chymical oils are volatile; that also several salts, obtained by the analysis of many concretes, are very volatile, is plain from their ascending in distillation. How easily water ascends in vapours, every body has observed; and as for what they call the mercurial principle, this is so apt to be raised in the form of steam, that *Paracelsus* and others define it by that property: hence it seems, that chymists have been very inaccurate in their doctrine of qualities, and their respective principles; since they derive several qualities from the same principle, and ascribe the same quality to almost all their principles, and other bodies besides. And hence, also, we may learn to judge of the plea, which that fierce champion of the *Aristotelians* against the chymists, *A. Guntherus Billiarius* makes, where he pretends to prove, against *Beguinus*, that not only the four elements immediately concur to constitute every mix'd body, and are both present in it, and obtainable from it, upon its dissolution; but that each of the *tria prima*, manifestly consists of all the four: "for," says he, "'tis true, in burning green wood we see " water in the sweat; air in the smoke; fire in the flame; and earth in " the ashes; but if *Beguinus* will collect the aqueous moisture, restrain the " oil, and extract the salt; I undertake to shew him all the four " elements in each of them, after his own method: thus, for example, " expose the water to the fire, and 'twill exhale in vapour; that is, " the air; whilst fire is perceptible in the heat, and earth in the sediment."

I might

I might easily shew how superficially this author talks of dividing the flame of green wood into his four elements, when he makes that vapour to be air, which caught in glasses, and condens'd presently, discovers it self to have been but an aggregate of innumerable very minute drops of liquor; and when he wou'd prove the phlegm to be compos'd of fire, by that heat which is adventitious to the liquor, and ceases upon the absence of what produced it. But I rather observe, that, taking it for granted fluidity must proceed from the element of water, he makes a chymical oil consist of that elementary liquor; and yet in the very next words proves, that it consists also of fire, by its inflammability; not remembring that exquisitely pure spirit of wine is both more fluid than water, and yet will wholly flame away, without leaving such matter behind it as he supposes to be earth. So that the same liquor may, according to his doctrine, be concluded, by its great fluidity, to be almost all water; and by its burning intirely away, to be all disguised fire. And, by the like method, our author would shew the fixed salt of wood to be compounded of the four elements; because being turned, by the violence of the fire, into steams, it shews it self to be of kin to air; tho' I doubt whether he ever saw a true fixed salt, brought by the fire alone, to ascend in the form of exhalations; but if he did, and had caught those exhalations in convenient vessels, he wou'd have found them, as well as the steams of common salt, &c. of a saline, and not of an aerial nature. And tho' he takes it, also, for granted, that the fusibility of salt must be deduced from water; it is, indeed, so much the effect of heat, variously agitating the minute parts of a body, without regard to water, that gold will be brought to fuse by a strong fire; which sure, is more likely to drive away, than increase, its aqueous ingredient, if it had any: and on the other side, for want of a sufficient agitation of its minute parts, ice is solid. Thus he presumes also, that the pungent quality of bodies must proceed from a fiery ingredient; tho' the light and inflammable parts, which are most likely to belong to the element of fire, must probably be driven away before the violence of the fire has reduced the body to ashes: and oil of vitriol, which quenches fire, burns the tongue and flesh of those who unwarily tast or apply it. But farther, it is precarious to prove the presence of fire in fix'd salts from their caustic power, unless it were first shewn, that all the qualities ascrib'd to salts, must be deduced from those of the elements; which is no easy task. And not to mention, that our author makes a body as homogeneous, as any he can produce for elementary, belong both to water and fire, tho' it be neither fluid, nor insipid, like water nor light, and volatile like fire; he seems to omit, in this analysis, the element of earth; only intimates, that the salt may pass for it; tho' a few lines before, he takes ashes for earth. But since there is a manifest difference betwixt the saline and insipid parts of ashes; I see not how substances, that



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disagree in such considerable qualities, can be both call'd portions of an element, whose nature requires it to be homogeneous: the saline part of ashes is very strongly tasted, and easily soluble in water, whilst the other part of the same is insipid, and indissoluble in that liquor: not to add, that the one substance is opaque, and the other somewhat diaphanous; nor that they differ in several other particulars; so that both these substances cannot well be elementary earth. And as to what is sometimes objected, that the saline taste of ashes is only an effect of the fire; we before shew'd, that tho' insipid earth may, perhaps, by additions, be turn'd into salt; yet 'tis not likely, that it should be so by the fire alone. In refining gold and silver, the most violent fire we can employ, gives them not the least relish of saltiness. And refiners, we have said, use bone-ashes for tests and cupels, which ought to be destitute of salt, lest the violence of the fire should bring them to vitrification. And indeed, having purposely tasted a cupel, made of only bone-ashes and fair water, which I had caus'd to be expos'd to a very violent fire, blown with a large pair of double bellows, I could not perceive, that the force of the fire had imparted to it the least saltiness, or so much as made it less insipid.

But farther, when our author, tho' a learned man, and one who pretends skill enough in chymistry to reform the whole art, comes to give us an ocular demonstration, as he calls it, of the immediate presence of the four elements in the resolution of green wood; he is oblig'd to say things inconsistent with one another: for, he makes the sweat, as he terms it, of green wood, to be water; the smoke, air; the shining matter, fire; and the ashes, earth; tho' presently after, he will, in each of these, nay, in one distinct part of the ashes, shew the four elements. So that either the former analysis, must be insufficient to prove that number of elements; since the burnt concrete is not thereby reduced into elementary bodies, but into such as are yet each of them compounded of the four elements; or else these qualities, from which he endeavours to deduce the presence of all the elements in the fix'd salt, and each of the other separated substances, will be but a precarious proof; for the extracted alkali of wood, being, for ought appears, as similar a body as any the *Peripatetics* can shew us; if its different qualities must argue the presence of distinct elements, it will scarce be possible for them, by any way of employing the fire upon a body, to shew that any substance is the portion of a true element. This shews, that the *Peripatetics*, as well as the chymists, take some things for granted, which they ought to prove. And when *Senmertus* infers, that because the qualities he mentions, as colours, odours, and the like, belong not to the elements, they therefore must to the chymical principles; he takes that for granted, which will not easily be prov'd. Thus much may suffice, to shew the weakness of supposing that almost every quality must have some native recep-

receptacle, wherein, as in its proper subject of inhesion, it peculiarly *Chymistry* resides; and on whose account that quality belongs to the other bodies, wherein it is to be met with. And this fundamental hypothesis being destroyed, whatsoever is built upon it must fall.

I further consider, that chymists are far from being able to explain, by any of the *tria prima*, those qualities of matter which they pretend to belong primarily to it, and in mix'd bodies to deduce from it. 'Tis true indeed, such qualities are not explicable by the four elements; but it will not therefore follow, that they are so by the three hermetical principles.

I allow then, that the chymists do justly accuse the doctrine of the four elements of insufficiency: but I am mistaken if our hermetical philosophers themselves, need not, as well as the *Peripatetics*, have recourse to more fruitful and comprehensive principles than the *tria prima*, to make out the properties of the bodies they converse with. Thus the vulgar chymists ascribe colours, for instance, to mercury; *Paracelsus*, to salt; and *Sennertus*, to sulphur. And *Sennertus*, I fear, wou'd have been exceedingly puzzled to solve, by the *tria prima*, half that catalogue of problems, which he challenges the vulgar *Peripatetics* to explain by the four elements. And supposing it true, that salt or sulphur were the principle to which this or that quality may be peculiarly referr'd; yet this is not enough, in any tolerable measure, to satisfy an inquisitive searcher after truth. For what is it to know, that such a quality resides in such a principle or element, whilst I remain altogether ignorant of the cause of that quality, and the manner of its production and operation? How little do I know, more than any ordinary man, of gravity, if I know no more than that the heaviness of mixed bodies proceeds from that of the earth they are compos'd of; and know not why the earth is heavy? And how little does the chymist instruct the philosopher in the nature of purgation, if he only tells him, that the purgative virtue of medicines resides in their salt? Tho' to this it may be objected, that the purging parts of many vegetables, extracted by infusion, are mix'd with oil, and spirit, and earth; and that quick-silver precipitated, either with gold or without it, into a powder, is strongly cathartic, notwithstanding the chymists have not proved, that either gold or mercury contain any salt at all, much less any that is purgative. But even upon their own supposition, what is it to know that the salt of rhubarb, for instance, purges, if that does not purge as salt; for scarce any elementary salt is, in a small quantity, cathartic; and if we know not how purgation in general is effected in a human body? In a word, as 'tis one thing to know a man's lodging, and another to be acquainted with him; so it may be one thing to know a subject, wherein a quality resides, and another to have a right notion of the quality itself. Now the reason of this deficiency seems to be the same which renders the *Aristotelian*, and several other theories, insufficient to explain

*Chymistry.* plain the origin of qualities. For I am apt to think, men will never be able to account for the phenomena of nature, while they endeavour to deduce them only from the presence and proportion of particular material ingredients; and consider them in a state of rest: most of the properties of matter seem to depend upon the motion and contrivance of the small parts of bodies. 'Tis by motion, that one part of matter acts upon another; and 'tis, for the most part, the texture of the body, upon which the moving parts strike, that modifies the motion or impression, and concurs with it, to produce those effects which come under the consideration of the naturalist.

It will still be urged, that this is an useful discovery; for, since in the salt of one concrete, in the sulphur of another, and in the mercury of another, the medicinal virtue of it resides; that principle being separated from the rest, the desired faculty may be obtained. But such doctrine seems useful to apothecaries, rather than philosophers; to make things operate being sufficient to the former; whilst the cause is the thing look'd after by the latter. Besides, it will not presently follow, that because the purgative, or other virtue of the simple, may be easily extracted by water, or the spirit of wine, that it resides in the salt or sulphur of the concrete; since unless the body hath before been resolv'd by the fire, or some other powerful agent, it will, for the most part, afford in those liquors, rather the finer compound parts of it self, than such as are elementary. Thus water will not only dissolve pure salt, but crystals of tartar, gum arabic, myrrh, and other compound bodies; and spirit of wine, not only the pure sulphur of concretes, but likewise the whole substance of several resinous bodies, as *Benzoin. Gum. Lacca*, &c. And we see, that the extracts, made either with water or spirit of wine, are not of a simple and elementary nature; but masses, consisting of the looser corpuscles and finer parts of the concretes, whence they are drawn; since by distillation they may be divided into more elementary substances.

Again, when there intervenes a chymical resolution, by the fire, 'tis seldom in the more saline or sulphureous principle, that the desired faculty of the concrete resides; but that titular salt, or sulphur, is yet a mix'd body, tho' the saline or sulphureous nature be predominant in it. For if the substances, thus separated, were pure, simple, and of a perfect elementary nature, no one wou'd be endowed with more specific virtues than another; and their qualities wou'd differ as little as those of water. And, by the way, even eminent chymists have used too great diligence in purifying some of the things, they obtain by fire, from mix'd bodies. For tho' such compleatly purified ingredients of bodies might, perhaps, be more satisfactory to our understanding; yet others are often more useful to our lives: the efficacy of such chymical productions depending most upon what they retain of the bodies, whence they are separated, or gain by the new associations of the disjoined parts; whilst, if they were merely elementary,



mentary, their uses would be comparatively very small; and the virtues of salts, sulphurs, or other such substances of one denomination, would prove the very same. For by these associations, probably, the number of mixed bodies is considerably increased; and many of those new productions endowed with useful qualities; which they often owe, not to the body from which they were obtained, but barely to this new texture.

But as there are several concretes, whose faculties reside in one or other of those different substances, call'd their sulphurs, salts, and mercuries, and consequently may be best obtained by a chymical analysis; so there are others, wherein the noblest properties lodge not in the salt, sulphur, or mercury, but depend immediately upon the form, or result from the determinate structure of the whole concrete; and, consequently, those who attempt to extract the virtues of such bodies by the violence of the fire, act so as to destroy what they would obtain.

*Helmont* himself confesses, that as the fire meliorates some things, and improves their virtues; so it spoils others. And other chymists have declared themselves of the same opinion.

None of the substances, into which the fire divides salt-petre, retain the taste, the cooling virtue, or some other of the properties of the concrete; whilst each of those substances acquires new qualities, not to be found in salt-petre it self. The shining property of the tail of a glow-worm, survives so short a time, the little animal made conspicuous by it, that inquisitive men have not scrupled publicly to deride *Baptista Porta*, and others; who deluded, perhaps, with some chymical firmizes, have ventured to prescribe the distillation of a water, from the tails of glow-worms, as a sure way to obtain a liquor shining in the dark. And to add another example, amber, whilst it remains an entire body, has a faculty of drawing to it self feathers, straws, &c. which I never could observe, either in its salt, its spirit, its oil, or in the body, I once made by re-uniting its divided elements. And, however boldly chymists deduce particular properties, from a determined proportion of their component principles; yet 'tis not always so much by virtue of the presence, or plenty of an ingredient, that the concrete is qualified to produce particular effects, as upon account of the particular texture of that, and the other ingredients, associated after a peculiar manner into one concrete: tho, possibly, such a proportion of that ingredient, may be more convenient than another, to constitute such a body. Thus in a clock, the hand is mov'd, the bell is struck, and the other actions belonging to the engine perform'd; not because the wheels are of brass or iron, or part of one metal, and part of another, or because the weights are of lead; but by virtue of the size, shape, and connection of the several parts; which would perform the same things, tho' the wheels were of silver, lead, or wood, and the weight of stone; provided the fabric, or contrivance of the engine,

were

*Chymistry.* were the same; tho' brass and steel are more convenient to make clock-wheels of, than lead or wood. Lead, barely by various applications of the fire, will lose its colour, and acquire sometimes a grey, sometimes a yellowish, sometimes a red, and sometimes an amethystine one; and after having pass'd thro' these, and, perhaps, several others, again recover its own colour, and be made a bright body: and tho' so flexible a metal, it may be made as brittle as glass; and presently be brought again to be flexible and malleable as before. Nay, the same lead, which thro' a microscope appears to be one of the most opaque bodies in the world, may be reduced to a fine transparent glass; whence yet it may return to an opaque nature again; and all this without the addition of any extraneous body; but merely, as we said, by the manner and method of exposing it to the fire.

Upon the whole, we may very well doubt, whether there be any determinate number of elements, or whether all compound bodies consist of the same number of material principles. For it appears from the experiments brought by the common *Peripatetics*, or by the vulgar chymists, to demonstrate that all mixed bodies consist precisely of the four elements, or the three hypostatical principles, are invalid and defective; that the other common arguments, pretended to be drawn from reason, in favour of the *Aristotelian* hypothesis, are generally grounded upon such unreasonable, or precarious suppositions, that they may as well be rejected as allowed; that if what *Paracelsus* and *Helmont* positively deliver of the alkahest, be true; it must be decided, which of the two resolvers, that, or the fire, shall determine the number of the elements, before we can be certain, how many there are; and that, as the distinct substances, whereinto the alkahest divides bodies, are affirmed to be different in nature, from those into which they are reduced by fire, and to be obtained from some bodies, more in number, than from some others; so, altho' we should acquiesce in that resolution which is made by fire, we find not that all mixed bodies are thereby divided into the same number of elements and principles; and, lastly, that 'tis no more necessary to the variety, which so greatly conduceth to the perfection of the universe, that all bodies should be compounded of the same number of elements; than it would be, for a language to have all its words consist of the same number of letters.

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## S E C T. VI.

Whether there  
be any elements  
at all?

**I**T may, perhaps, seem extravagant to doubt, whether there be a necessity to admit any elements, or hypostatical principles at all.

But supposing them to be certain primitive, simple, or perfectly

fectly unmixed bodies, which not being made of any others, or of one another, are the ingredients whereof all those called perfectly mixed bodies, are immediately compos'd; and into which they are ultimately resolv'd; I here propose to examine, whether there be any one such body to be constantly met with. *Chymistry.*

The case being thus stated, I am not reduced to deny, that there are such bodies as earth, and water, quick-silver, and sulphur; but I look upon earth and water as component parts of the terrestrial globe: and tho' I will not positively say, there may not, sometimes, either a running mercury, or a combustible substance, be obtained from a mineral or a metal; yet I need not allow either of them to be an element, in my sense.

In matters of philosophy, it seems a sufficient reason to doubt of an important proposition, when its truth is not established by any competent proof. And, therefore, if I shew that the grounds upon which men allow of elements, are unsatisfactory to considerate persons, I suppose my scruples will appear rational.

The considerations that induce men to think there are elements, may be referr'd to two heads: first, that it is necessary, nature should make use of them, to constitute the bodies reputed mix'd. And, secondly, that the resolution of such bodies, manifests nature to have compounded them of elementary ones.

Now the experiments above produced, concerning the growth of pumpions, mint, &c. shew, that water may be transmuted into all the other elements; from whence we infer, that 'tis not every thing which chymists call salt, sulphur, or mercury, that needs always be a primitive and ingenerable body; and that nature may form a plant, without having all the elements previously prepared, whereof to compound it. And if we allow the relation formerly mentioned of M. de Rochas; not only plants, but animals and minerals too, may be produced out of water. However, there is little doubt, but the plants my own experiments afforded me, would, in case I had reduced them to putrefaction, have produced worms, or other insects, as the resembling vegetables usually do; so that water may, by various seminal principles, be successively transmuted, both into plants and animals. And if we consider, that not only men, but sucking children, are often tormented with solid stones in the bladder or kidneys; and even beasts too, tho' they feed but upon vegetables, which, perhaps, are but disguised water; it will not seem improbable, that some concretes of a mineral nature may, likewise, be form'd of water.

And as a plant may be nourished, and, consequently, may consist of common water; so may both plants and animals be made up of compound bodies, without having any thing merely elementary, afforded them by nature, to be compounded. This is evident in men, who, whilst they were infants, fed only on milk; and, afterwards, altogether upon flesh, fish, wine, and other perfectly mix'd bodies. It may be

*That bodies are not compos'd from all the mere elements, shewn in the growth of vegetables, and animals.*



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seen also in sheep, who, on some of our *English* downs, grow very fat, by feeding upon the grass, without scarce drinking at all; and yet more manifestly in maggots, that feed and grow up to their full size, within the pulp of apples, pears, or the like fruit. We find also, that such dungs as abound with a mixed salt, hasten the growth of corn, and other vegetables, much more than water alone. And a man experienced in such matters, assures me, that, sometimes, when, to bring up roots very early, the mould they were planted in was made over-rich, the very substance of the plant has tasted of the dung. And let us consider a graft of one kind of fruit, upon the upper bough of a tree of another kind; as for instance, the scion of a pear upon a white-thorn; for there the ascending liquor is already alter'd, either by the root, or, in its ascent, by the bark, or both, and becomes a new mix'd body; as may appear by the different qualities, to be met with in the saps of several trees; particularly the medicinal virtue of birch-water, which I have sometimes drunk, upon *Helmont's* great and deserved commendation. Now the graft being fasten'd to the stock, must necessarily nourish it self, and produce fruit only out of this compound juice, prepared for it by the stock; being unable to come at any other aliment. And considering how much of the vegetable fed upon, may remain in an animal; 'tis easy to imagine, that the blood of that animal which feeds upon this, tho' a well constituted liquor, with all the different corpuscles that make it up, and kept in order by one presiding form, may be a strangely compounded body; many of its parts being themselves compounded. So little necessity is there, that even in the mixtures which nature her self makes in animal and vegetable bodies, she should have pure elements at hand to compose them of.

As much might, perhaps, be said of minerals, and even metals, if it were as easy for us to make experiments, in order to the production of them, as of plants and animals. But the growth or increase of minerals, being usually very slow; and, for the most part, perform'd in the bowels of the earth, where we cannot see it; I must, instead of experiments on this occasion, make use of observations.

And of minerals and metals.

That stones were not all made at once, but that some of them are successively generated; may be fully prov'd by several examples. There is a famous place in *France*, known by the name of *les Caves Goutieres*, where the water falling from the upper parts of the cave to the ground, presently condenses there into little stones, of such figures as the falling drops chance to exhibit; some of which stones have been presented me. And both *Linschoten*, and another eminent author, inform us, that, in the diamond-mines in the *East-Indies*, when having dug the earth, tho' to no great depth, they find diamonds, and take them quite away; yet in a very few years, they find new ones produced in the very same place; whence it seems probable, that nature does not always require elementary bodies to produce stones. And as for metals, authors of good note assure us, they have been observed to grow;

grow; so that what was not a mineral or metal before, became one afterwards. Of this it were easy to alledge many testimonies of profess'd chymists, and other less suspected authors. "Sulphur," says *Fallopium*, "presently grows under ground: there are places where that mineral having been once dug, and suffer'd to rest for four years, yield plenty of it again. *Pliny* relates, that iron grows in the island *Ilva* in *Italy*; and *Strabo* expressly tells us, that 'tis there dug up, and continually grows again in the space of an hundred years." *Cesalpinius* declares, "there is a very plentiful vein of iron in *Italy*;" and that "the island *Ilva* is famous for the growth of it; so that the earth cast up in digging a vein there, will, in tract of time, be wholly turn'd into a vein again." And *Agricola* owns, that "at a town call'd *Saga*, in *Germany*, they dig up iron in the fields, by sinking ditches two feet deep;" and adds, that "within the space of ten years, the ditches are dug again for iron newly produced; as that metal is obtained in *Ilva*." Not to mention what *Galen* notes concerning lead, that it will increase both in bulk and weight, if long kept in vaults or cellars; as he gathers from the swelling of those pieces of it, which were employed to fasten together the parts of statues; *Boccacius Certaldus* relates, that "there are lead-stones in a mountain near *Florence*; which, if hewn out, will, in a short time, have their place supplied by new ones." *Pliny* also mentions, "some lead-mines, where the dross being thrown in heaps, and suffer'd to lie exposed to the weather for a few years, yielded a large increase of that metal." 'Tis deliver'd by *Gerhardus*, that "in the valley of *Foachim*, silver is found to grow from the stones of the mine, in the nature of grass, as from a root, to the length of a man's finger;" and mentions *Dr. Schreter* as an eye-witness; who, also, kept by him many pieces of that very metal, surprizingly figured.

That industrious chymist, *Johannes Valehius*, relates, with many concurring substances, that at a mine, not far from *Strasburg*, call'd *Maria-kirch*, a workman accidentally found a large mass of pure silver, weighing 500 pounds, in a hollow place under ground, with no vein, or ore, near it; only something like a burnt matter underneath; from which and other circumstances, our author concludes, that by the warmth of the place, the noble metalline spirits were carried from the neighbouring galleries, or vaults, thro' other smaller cracks and clefts, into that cavity; and there collected, as in a close chamber, into one large lump.

And, lastly, *Agricola* relates, that when he was among the *Hungarian* mines, he observed, there would often arise in the deep grooves, a warm, innocent steam, which fasten'd it self to the sides; and that coming to review it in two days time, he discern'd it all very fix'd and glittering; whereupon having collected it, and distill'd it *per retortam*, he thence obtained a fine spirit: he adds, that the miners informed him, this steam would, at last, have become a metal, as gold or silver.

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From all this, 'tis not very probable, that, whensoever a mineral, or a metal, is to be generated in the bowels of the earth, nature must needs have at hand, salt, sulphur, and mercury, to compound it; for not to urge, that the two last relations seem less to favour the chymists, than *Aristotle*, who wou'd have metals generated of steams; all the observations, taken together, make it seem more likely, that the mineral earths, or those metalline steams, contain some feminal rudiment, or what is equivalent thereto; by whose plastic power, the rest of the matter, tho', perhaps, terrestrial and heavy, is, in tract of time, fashion'd into particular metalline ores, almost, as we formerly observ'd, fair water was, by the feminal principle of mint, pompions, and other vegetables, contrived into bodies, answerable to their seeds. And that such alterations of terrestrial matter, are not impossible, seems evident from that notable practice of the salt-peter boilers; who unanimously observe, that if an earth, pregnant with nitre, be depriv'd by the affusion of water, of all its true and dissoluble salt; yet the same earth will, after some years, yield them salt-peter again. For which reason, some of the most eminent and skilful of them, keep it in heaps, as a perpetual mine of salt-peter: whence it may appear, that the feminal principle of nitre, latent in the earth, does, by degrees, transform the neighbouring matter into a nitrous body.

A person of great credit, and well acquainted with the ways of making vitriol, affirm'd to me, that he had observ'd a kind of mineral, which abounds in that salt, did, by being kept within doors, and not expos'd to the free air and rains, of it self, in no very long time, turn to vitriol, not only in the outward, or superficial, but even in the most central parts.

And, I have also met with a certain kind of marcasite, that lay together in great quantities under ground; which, even in my chamber, began, in a few hours, of it self, to turn into vitriol. Now, as nature, we see, makes salt-peter out of the earth, that was once almost scentless, and did not find a very fetid, and corrosive acid liquor, and a sharp alkaline salt to compound it of; tho' these are the bodies, into which the fire resolves it; so it were not necessary, that nature should make up all metals, and other minerals, of pre-existent salt, sulphur, and mercury, tho' such bodies might, by fire, be obtain'd from them. This consideration, duly weigh'd, is very considerable in our present enquiry: and hereto agree the relations of our two *German* chymists; for it is very improbable, that so languid and moderate a heat, as that within the mines, should carry up, to so great a height, salt, sulphur, and mercury; since we find, in our distillations, that it requires a considerable degree of fire, to raise to the height of one foot, not only salt, but even mercury it self, in close vessels. And if it be objected, that, it seems, by the ill scent, sometimes observ'd after lightning, that sulphureous steams may ascend very high, without any

extra-



extraordinary degree of heat; I answer, that the sulphur of silver, is, *Chymistry*.  
by chymists, said to be a fix'd one.

But the *Aristotelians*, and vulgar chymists, I presume, know no better than I, *à priori*, of what ingredients, nature compounds metals and minerals. For their argument, to prove that those bodies consist of such principles, is drawn *à posteriori*; I mean, their chymical analysis, which is the second topic from whence they argue.

Now, tho' chymists pretend to draw salt from some minerals, running mercury from others, and from others a sulphur, yet they have not, hitherto, taught us, by their practice, to separate any one principle from all sorts of minerals, without exception; and thence, I conclude, none of them to be an ingredient of all bodies.

But, supposing that either sulphur, or mercury, were obtainable from all sorts of minerals; still this sulphur, or mercury, would be a compound, not an elementary, body\*. And certainly, he who takes notice of the wonderful operations of quick-silver, either the common, or that drawn from mineral bodies, can scarce be so inconsiderate, as to think it of the very same nature, with that immature and fugitive substance, which chymists call the mercury of vegetable and animal substances. So that when mercury is obtain'd, by the help of the fire, from a metal, or other mineral body; if we are unwilling to suppose it not pre-existent therein, but produced by the action of the fire, we may, at least, allow this quick-silver to have been a perfect body of its own kind, which happen'd to be intimately mingled and coagulated with the other substances, whereof the metal, or mineral, consisted. This may be exemplified by native vermillion; wherein the quick-silver, and sulphur, being exquisitely blended both with one another, and that coarse mineral stuff that harbours them, make up a red body, different enough from both; and yet from hence, part of the quick-silver and of the sulphur, may be easily obtain'd. Thus also in some mines, nature has so curiously incorporated silver with lead, that 'tis extremely difficult, and yet possible, to separate the former from the latter. And so in native vitriol, the metalline corpuscles are, by skill and industry, separable from the saline ones; tho' they be so coagulated with them, that the whole concrete is reckon'd among salts. Now I never could see any earth or water, properly so call'd, separated from gold or silver; and therefore, to retort the argument, I conclude, that since there are

*The same  
shewn, also,  
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lysis of bodies.*

\* M. Homberg has shewn, that all mineral acids will dissolve quick-silver; that some of them dissolve it easier than others; that some dissolve it totally, others but in part; leaving a blackish sediment at the bottom, which nevertheless is easily dissolved by some other acid; that by a particular operation,

made to purify mercury exactly, he obtain'd from it a quantity of a light grey powder, of different properties from, but essential to it; whence he concludes, that quick-silver is not homogeneous in all its parts.] *Memoir, de l'Academ. A. 1700. p. 245.*

*Chymistry.* some bodies, in which, for ought appears, there is neither earth nor water; neither of those is an universal ingredient of all bodies, counted perfectly mix'd.

It may indeed be said, that the reason why from gold, or silver, we can separate no moisture, is, because when it is melted out of the ore, the vehement fire, requisite to its fusion, forc'd away all the aqueous and fugitive parts. But *Josephus Acosta*, relates it, upon his own observation, that in *America*, there is a kind of silver, whereof the *Indians* sometimes find pieces, very fine and pure, like small round roots; which, tho' rare in that metal, is usual in gold: and, besides this, says he, they find some, which they call gold in grains; which are small pieces, without mixture of any other metal, and have no need of melting or refining in the fire. And a very skilful, and credible person, affirm'd to me, that being in the *Hungarian* mines, he had the good fortune to see a mineral, that was there dug up, wherein pieces of gold, of the length, and also almost the bigness, of a human finger, grew in the ore, as if they had been parts and branches of trees. And I have my self seen, a lump of whitish mineral stone, that look'd like a kind of spar, wherein there grew, here and there, several little lumps of fine gold, some of them about the bigness of pease.

But *Acosta* tells us, he has seen pieces of pure native gold, that weigh'd several pounds. And I my self, have seen a piece of ore, lately dug up, in whose stony part there grew, almost like trees, several parcels of a metal, which seem'd to be very pure, or unmix'd with any heterogeneous substances; and were some of them as big as my finger.

To proceed to the consideration of the analysis of vegetables. My trials indeed, give me no cause to doubt, that five different substances, may, generally, be obtain'd from them by the fire; yet, I think, it will not be easily demonstrated, that these deserve to be call'd elements, in the sense above deliver'd.

And before I descend to particulars, I must premise this general consideration, that these different substances called elements, or principles, differ not from each other, as plants, animals, and metals; or as creatures, immediately produced, each by its peculiar seed, and constituting a distinct propagable sort of creatures in the universe; for these are only various schemes of matter, that differ from each other, but in consistence, and some very few other accidents, as taste, smell, inflammability, or the want of them; so that by a change of texture, not impossible to be wrought by the fire and other agents, that have the faculty to dissociate the small parts of bodies, and afterwards to connect them after a new manner, the same parcel of matter may acquire or lose such accidents as suffice to denominate it salt, sulphur, or earth; whence the fire may as well produce some new textures, in a parcel of matter, as destroy the old.

If we doubt not the truth of some of *Helmont's* relations, we may well question, whether any of these heterogeneous substances exist in the concrete, whence they are obtain'd by the chymical analysis. For, not to insist upon the unflammable spirit of such concretes; because that may be pretended to be but a mixture of phlegm and salt; the oil or sulphur of vegetables or animals is, according to him, reducible, by the help of lixivate salts, into sope; as that sope is, by repeated distillations, from a *Caput mortuum* of chalk, into insipid water. And as for the saline substance, that seems to be separable from mixed bodies; the same *Helmont's* tryals give us cause to think it may be a production of the fire, which, by transposing and otherwise altering the particles of the matter, brings it to a saline nature. "For I know," says he, "a way to reduce all stones into a meer salt, of equal weight with that from whence it was produced, without the least mixture of either sulphur or mercury." Which asseveration wou'd, perhaps, seem less incredible, if I durst here say all I cou'd upon that subject. And hence, by the way, we may, also, conclude, that the titular sulphur and mercury, obtained by analysis, from compound bodies, may, possibly, in many cases, be the productions of fire; since, if the same bodies had been wrought upon by *Helmont's* agents, they would have yielded neither sulphur nor mercury; and those portions of them, which the fire wou'd have presented in the form of sulphureous and mercurial bodies, might, by his method, have been exhibited in the form of salt.

But it is not so easy to reject water and earth, especially the former, as 'tis to reject the *tria prima*, from among the elements of mix'd bodies: however, every difficult thing is not impossible. As to water, the chief qualities which occasion men to give that name to any visible substance, are, that it is fluid, insipid, and inodorous: but I have never seen any of those separated substances chymists call phlegm, which was perfectly destitute both of taste and smell. And if it be said, that since the whole body is liquid, the mass is nothing but elementary water, faintly imbued with some of the saline or sulphureous parts of the same concrete, which it retain'd upon its separation from the other ingredients; I answer, that this objection wou'd not appear so strong as plausible, if chymists understood the nature of fluidity and compactness. I formerly observed that, to make a body fluid, there is nothing necessary but that it be divided into parts small enough; and that these parts be put into such a motion amongst themselves, as to glide some one way and some another, along each others surfaces; so that altho' a concrete were never so dry, or had not any water, or other liquid existent in it; yet such a comminution of its parts may be made by the fire, or other agents, as to turn a great portion of them into liquor. For if sea-salt be melted in the fire, to free it from the aqueous parts, and afterwards distill'd with a vehement heat, from burnt clay, or any other very dry *Caput mortuum*,

Chymistry.

The *tria prima* seem to be productions of the fire.

Phlegm not an universal and pre-existent ingredient of mixed bodies.



*Chymistry.* *um*, a large portion of the salt will be driven over in the form of a liquor. And to shew, that a great part of this liquor was still true sea-salt, brought by the operation of the fire into corpuscles so small, and, perhaps, so advantageously shap'd, as to be capable of the form of a fluid body; I poured to such spirituous salts a due proportion of the spirit of urine, and thereby, having evaporated the superfluous moisture, soon obtain'd such another concrete, both as to taste, smell, and easy volatility, as common sal-armoniac. And further, to manifest that the corpuscles of the sea-salt, and the saline ones of urine, retain their several natures in this concrete, I mixed it with a convenient quantity of salt of tartar, and committing it to distillation, soon regained the spirit of urine, in a liquid form by its self; the sea-salt remaining behind with the salt of tartar. It is, therefore, very possible, that dry bodies may, by the fire, be reduced to liquors, without any separation of elements; but barely by a certain kind of dissipation and comminution of the matter, whereby its parts are brought into a new state. If it be still objected, that the phlegm of mix'd bodies must be reputed water, because so weak a taste needs but a very small proportion of salt to impart it; I reply, that for ought appears, common salt, and several other bodies, tho' distill'd whenever to dry, and in vessels ever so close, will yield, each of them, a considerable quantity of a liquor, wherein, tho' as I lately noted, saline corpuscles abound, yet there is besides, a large proportion of phlegm; as may be easily discovered by coagulating the saline corpuscles with any convenient body; as we coagulated part of the spirit of salt with spirit of urine. And I have often separated a salt from oil of vitriol it self, by boiling it with a just quantity of mercury, and then washing the newly coagulated salt from the precipitate, with fair water. Now to what can we more probably ascribe this plenty of an aqueous substance, afforded by the distillation of such bodies, than to this, that among the various operations of the fire upon the matter of a concrete, several particles of that matter are reduced to a shape and size requisite to compose such a liquor, as the chymists call phlegm, or water? 'Tis proper here to reflect upon what we formerly said, concerning the change of quick-silver into water; for the water having but a very faint taste, if at all more than many of those liquors which chymists refer to phlegm; it seems evident from such an experiment, that even a metalline body, and, therefore, much rather a vegetable or animal one, may, by a simple operation of the fire, be turn'd, in great part, into water. And since the chymists are not yet able out of gold, silver, &c. to separate any thing like water; I may be allow'd to conclude against them, that water is not an universal and pre-existent ingredient of mix'd bodies.

But supposing the truth of what *Helmont* relates of the alkahest's effects; it may be alledg'd, that he could transmute all reputed mix'd bodies into mere insipid water. But tho' his affirmations conclude strong-

strongly against the vulgar chymists, since they prove, that the common principles, or ingredients of things, are not permanent and indestructible, because they may be further reduced into insipid phlegm, different from them all; yet, till we can be allow'd to examine this liquor, it is not unreasonable to doubt, whether it be not something else than meer water. For, I find no other reason, why *Helmont* pronounces it so, but because it is insipid. Now sapor, being a property of matter, that relates to our organs of tast; it may very possibly happen, that the small parts of a body shall be of such a size and shape, as either by their extreme minuteness, by their slenderness, or by their figure, to be unable to pierce into, and make perceptible impressions upon the nerves, or membranous parts of the tongue or palat; and yet be fit to work otherwise upon several bodies, than meer water, and, consequently, to shew it self to be of a nature far from elementary. In dyed silk, whilst many contiguous threads make up a skein, the colour is conspicuous; but if only a very few of them be view'd, the colour will appear much fainter than before; and if only a single thread, 'tis not easie to discern any colour at all; so subtile an object wanting the force to make an impression upon the optic nerve, great enough to be taken notice of. It is also observ'd, that the best sort of oil-olive is almost tasteless, tho' it be vastly remote in nature, from water. The liquor, into which mercury may be transmuted, has, sometimes, but a very languid tast; yet its operations, even upon some mineral bodies, are very peculiar. Quick-silver it self, also, tho' the corpuscles it consist of are so very small, as to get into the pores of gold, is altogether tasteless. And *Helmont* several times tells us, that fair water, wherein a little quantity of quick-silver has lain for some time, tho' it acquire no certain tast, or other sensible quality, has a power to destroy worms in a human body. And a great lady, eminent for her beauty in several courts, confess'd to me, that this insipid liquor was, of all innocent washes for the face, the best she ever met with.

Besides, it deserves to be remark'd, that, as we are accustomed to drink nothing but wine, beer, or other strongly tasted liquors, there may be in several of those that pass for insipid phlegm, very peculiar and distinct tastes, tho' unheeded by us. For, to omit what naturalists affirm of apes, that they have a more exquisite palat than us; among men themselves, those who drink nothing but water, may, as I have try'd in my self, discern a great difference of tast in several waters; which one unaccustomed to drink water, wou'd take to be all alike insipid. And 'tis not impossible, that the corpuscles, into which a body is dispersed by the fire, may thereby have their figures so altered, or, by associations with one another, be brought into little masses, of such a size and shape, as to be unfit to make sensible impressions on the tongue. The sharpest spirit of vinegar having dissolv'd as much coral as it can, will coagulate with it, into a

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substance, which, tho' soluble in water, like salt, is incomparably less strongly tasted than the vinegar was before. And tho' the acid salts carried up with quick-silver in the preparation of common sublimate, are so sharp, that, moistened with water, they will corrode metals; yet this corrosive sublimate, being twice or thrice re-sublim'd with a full proportion of insipid quick-silver, constitutes *Mercurius dulcis*; so call'd, because the sharpness of the corrosive salts is so taken away, by their combination with the mercurial corpuscles, that the whole mixture, when prepared, is judg'd insipid.

Nor earth.

For such reasons I cannot admit elementary water as a constant ingredient of mix'd bodies. And as for earth, it may well be suspected, that many substances pass, among chymists, under the name of it; only because, like that, they are dry, heavy, and fix'd; tho' yet very far from an elementary nature. This seems probable from what I formerly said of that the chymists call the *terra damnata* of things, and particularly concerning the copper to be drawn from the *Caput mortuum* of vitriol; to which we may add a remarkable experiment made by *Johannes Agricola* upon the *terra damnata* of brimstone. This author tells us, that having prepared an oil of sulphur, he reverberated the remaining feces, in a moderate fire, for fourteen days; and afterwards put them, well luted up, in a wind-furnace, with a strong fire, for six hours; proposing to calcine them to perfect whiteness. But coming to break the pot, he found very little feces on the top, and those grey; whilst beneath there lay a fine red regulus, which, at first, he knew not what to make of; being well assured, that not the least thing besides the feces of the sulphur came into the pot; and that the sulphur it self had only been dissolved in linseed oil. This regulus he found heavy and malleable, almost as lead. Having caus'd a goldsmith to draw him a wire of it, he found it to be of the finest copper, and so rightly colour'd, that a Jew of *Prague* offer'd him a great price for it. And of this metal, he says, he had six ounces from one pound of feces. Hence we may well suspect, that since the *Caput mortuum* of the sulphur remain'd so long in the fire, before it was found to be any thing else than a *terra damnata*; there may be other residences of bodies, which pass only for the terrestrial feces of things, and are therefore thrown away as soon as the distillation or calcination is ended, which yet, if long and skilfully examined by the fire, would appear to be different from elementary earth. And I have taken notice of the unwarrantable forwardness of common chymists, to pronounce things useles feces, by observing how often they reject the *Caput mortuum* of verdigrease; which is so far from deserving to be call'd so, that not only by strong fires and convenient additions, it may, in some hours time, be reduced to copper; but with a certain flux-powder, I have, in two or three minutes, obtain'd that metal from it. And having kept *Venetian* talc, in the heat of a glass-furnace, I found, after all the violence of the fire it had endured, the remaining body, tho' brittle and discolour'd, had not

lost



lost very much of its former bulk; and seemed still to be nearer allied to talc, than to meer earth. And I remember too, that a candid mineralist, famous for his skill in trying ores, importuning me to procure him a certain *American* mineral earth; I enquired of him, why he seemed so desirous of it; when he confess'd, that it having been brought to the public say-masters, and they being unable by any means to bring it to fusion, or make it fly away, he had procured a little of it; and having try'd it with a peculiar flux, he separated from it near a third part of pure gold: so great mistakes may be committed in hastily concluding things to be uselefs earth!

Next, 'tis possible, that as in the resolution of bodies by the fire, some of the dissipated parts may, by their various occurrsions, be brought to stick so closely together, as to constitute corpuscles, too heavy for the fire to carry away; so, other agents may resolve the concrete into minute parts, after such a different manner, as not to produce any *Caput mortuum*, or dry and heavy body. Thus *Helmont* informs us, as we before observed, that with his great dissolvent, he divided a coal into two liquid and volatile bodies, equal in weight to the coal, without any dry or fixed residence at all. And, indeed, it seems not necessary, that all agents, which resolve bodies into portions of differently qualified matter, should work on them in the same way, and divide them into just such parts, both for nature and number, as the fire separates them into. For since, as I lately noted, the bulk and shape of the small parts of bodies, together with their fitness and unfitness, to be easily put into motion, may render the substances they compose, as different from each other, as some of the chymical principles; why may not something happen in this case, like what is usual in the grosser divisions of bodies by mechanical instruments? Thus some tools reduce wood, for instance, into parts of several shapes, bigness, and other qualities; as hatchets and wedges divide it into grosser portions, some more long and slender, and others more thick and irregular, all of considerable bulk; but rasps and saws make a comminution of it into dust; whilst others divide it into long, broad, thin, flexible parts, as planes. And of this kind of parts, it self, there is also a variety, according to the difference of the tools employed; the shavings made by the plane, being in some things different from those shives obtained by the borer.

In a mixture of sulphur, and salt of tartar, well melted and incorporated together, the action of pure spirit of wine digested on it, is to separate the sulphureous from the alkaline parts, by dissolving the former, and leaving the latter; whilst the action of wine upon the same mixture, is to divide it into corpuscles, consisting of both alkaline and sulphureous parts united. 'Tis true, this is but a factitious concrete; however, the instance may serve to illustrate what I propos'd, if not to prove it: and nature her self, in the bowels of the earth, makes compounded bodies, as we see in vitriol, cinnabar, and even in

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fulphur it self. Besides, fire divides new milk into five different substances; tho' runnet, and acid liquors, separate it but into a coagulated matter, and a thin whey; and, on the other hand, churning divides it into butter, and butter-milk; which may, either of them, yet be reduced to other substances, different from the former. And whereas spirit of wine will diffociate the parts of camphire, and make them one liquor with it self; *Aqua fortis* will also disjoin them, and put them into motion, but so as to keep them together, and yet alter their texture into the form of an oil. I know, also, an uncompounded liquor, that an extraordinary chymist would not allow to be so much as saline; which from coral it self, not only obtains a noble tincture, without the assistance of nitre, or other salts; but will carry it over in distillation. And I make a menstruum, that more oddly associates the parts of minerals very fix'd in the fire. Whence it seems not incredible, that there may be some agent, or way of operation found, whereby some concretes, if not all firm bodies, are resolvable into parts so very minute, and so apt to adhere closely to one another, that none of them may be fix'd enough to stay behind in a strong fire; and, consequently, are not to be look'd upon as earth. *Helmont*, also, affirms, that he can reduce all the terrestrial parts of mix'd bodies into insipid water; whence we may argue against the earth's being an element. And since a body, from which the fire hath driven its looser parts, is supposed to be earth, for being insipid and fix'd; if natural agents can deprive the *Caput mortuum* of a body, of either of those two qualities; or give them both to a portion of matter that had them not before; the chymists will not easily shew, what part of a resolv'd concrete is earth, or that earth is a primary, simple, and indestructible body. Now, there are some cases, wherein the more skilful of the vulgar chymists themselves, pretend to be able, by repeated cohobations, and other operations, to make the distilled parts of a concrete bring its own *Caput mortuum* over the helm, in the form of a liquor; in which state, being both fluid and volatile, it cannot well be taken for earth. And, indeed, by a skilful, but not vulgar way of managing some concretes, there may be more effected in this kind, than one would easily imagine. And, on the other hand, that either earth may be generated, or, at least, that bodies, which did not before appear to be totally earth, may be so alter'd as to pass for it, seems very possible, if *Helmont* hath done that by art, which he mentions in several places; especially where he says, that he knows ways whereby sulphur once dissolv'd, may, all of it, be fix'd into a terrestrial powder; and the whole body of salt-petre turn'd into earth.

And these things seem the less impossible, from what we have deliver'd as to the growth of vegetables, nourished by water alone. And *Rondeletius* tells us of a fish he kept in a glass of water, without any other food for three years; in which space it constantly augmented; till at length it could not come out of the orifice at which it was put.

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in; and, at last, grew too big for the glass it self. Now there is no just reason to doubt, that this fish, if distill'd, would have yielded the like different substances with other animals; and because the mint which I produced out of water, afforded me, upon distillation, a large quantity of charcoal; I think I may from hence infer, that earth it self may be produced out of water; or that water may be transmuted into earth; and, consequently, tho' earth could be proved an ingredient actually existent in the vegetable and animal bodies, whence it may be obtained by fire; it would not necessarily follow, that earth, as a pre-existent element, concurs with other principles to make up those bodies, whence it seems to have been separated.

It will, perhaps, be retorted upon me, that there may be elementary bodies; since I allow gold for an ingredient, in a multitude of different mixtures; which still retains its nature, notwithstanding all that the chymists, by their fires and corrosive waters, can do to destroy it.

But I propos'd this example, chiefly to shew how nature may be conceived to have made elements; not to prove that she actually has made any; and *a posse ad esse*, is no just inference. But to answer the objection more directly; I must own, that tho' many of the more sober chymists have complained of the vulgar ones, as of cheats, for pretending to destroy gold; yet I know a certain menstruum of so piercing and powerful a quality, that if, notwithstanding much care and some skill, I did not greatly deceive my self, I have with it, really destroyed even refined gold; and brought it into a metalline body, of a different colour and nature; as I found by trials purposely made. And I have learnt from experience, that a menstruum may be made to separate and retain several parts from bodies, which even the more judicious and experienced chymists have pronounced irresoluble by the fire; tho' in neither of these instances could the gold, or precious stones, be analyz'd into any of the *tria prima*; but only reduced to new concretes. And, indeed, there is a great disparity betwixt the operations of the several agents, whereby the parts of a body come to be separated. Thus, for instance, if you dissolve the purer sort of vitriol in common water, the fluid will swallow up the mineral, and so dissociate its corpuscles, that they will seem to make but one liquor with those of the water; and yet each of these corpuscles retains its nature and texture, and remains a vitriolate and compound body. But if the same vitriol be exposed to a strong fire, it will then be divided, not only, as before, into smaller parts, but into heterogeneous substances; each of the vitriolic corpuscles that remained entire in the water, being it self, upon the destruction of its former texture, divided into new particles of different qualities. And tho' there were saline, sulphureous, or terrestrial portions of matter, with parts so small, so firmly united together, or of a figure so fit to make them cohere to one another, that neither the fire, nor the usual agents employed by chymists, are piercing enough to divide their

Gold it self, destructible; and new qualities producible in bodies, by a bare change of texture.



*Chymistry.*

their parts, so as to destroy the texture of the single corpuscles; yet it would not necessarily follow, that such permanent bodies must be elementary; since 'tis possible there may be agents found in nature, some of whose parts are of such a size and figure, as to take better hold of these seemingly elementary corpuscles, than they do of the rest; and, consequently, may carry away such parts with them, and so dissolve the texture of the corpuscle, by pulling its parts asunder. And if it be said, that, at least, we may this way discover the elementary ingredients of things, by observing into what substances these corpuscles, that were reputed pure, are divided; I answer, 'tis not necessary such a discovery should be practicable. For if the particles of the dissolvent, take such firm hold of those of the dissolv'd substance, they must, together, constitute new bodies, as well as destroy the old. And the strict union which, according to this hypothesis, may well be supposed betwixt the parts of the produced body, will make it as improbable they should be sever'd but by particles of matter, that, to divide them, associate, and stick extremely close to such as they separate from their former adherents. Besides, it is not impossible, that a corpuscle, supposed to be elementary, may have its nature changed, without suffering a divorce of its parts, barely by a new texture, effected by some powerful agent; as I formerly said, the same portion of matter may, easily, by the operation of the fire, be turned into the form of a brittle and transparent, or an opaque and malleable body.

And, indeed, if we consider how far the bare change of texture, whether made by art or nature, can go, in producing such new qualities, in the same parcel of matter; and how many inanimate bodies we know to be denominated, and distinguished, not so much by any imaginary substantial form, as by the aggregate of these qualities; and that the variation of figure, size, motion, situation, or connexion of the corpuscles, whereof any of these bodies is composed, may alter the fabric of it; we shall have cause to suspect, that there is no need that nature should always have elements provided, whereof to compose mix'd bodies; and that it is not so easy as chymists and others have hitherto imagined, to discern, which among the many different substances, without any extraordinary skill, to be obtained from the same portion of matter, ought, exclusive of the rest, to be esteem'd its elementary ingredients; much less to determine what primogeneal and simple bodies conspir'd together to compose it.

I formerly intimated, that besides mint and pompions, I produced several other vegetables, of very different natures, out of water; and therefore, 'tis not absurd to suppose, that when a slender vine-slip, is set in the ground, and takes root there, it may, likewise, receive its nutriment from the water, attracted out of the earth by its roots, or impell'd by the warmth of the sun, or pressure of the ambient air, into the pores of them. This seems the more probable, from observing

what

what a strange quantity of water will drop out of the wound, given to the vine, in a convenient place, at a seasonable time, in the spring; and how little of taste, or smell, this liquor is endow'd with, notwithstanding what concoction, or alteration, it may receive in its passage thro' the vine, to discriminate it from common water. Supposing then, this liquor, at its first entrance into the roots of the vine, to be common water; let us a little consider, how many various substances may be obtain'd from it. And first, being digested in the plant, and assimilated by the several parts thereof, it is turn'd into wood, bark, leaves, &c. 'tis further modify'd and fashion'd into vine-buds; and these soon after, advance to four grapes; which express'd, yield verjuice; a fluid, very different, in several qualities, both from wine and other liquors, obtainable from the vine. These four grapes being, by the heat of the sun, concocted and ripen'd, turn to well-tasted grapes; which, if dry'd in the sun and distill'd, afford a fetid oil, and an empyreumatical spirit, but not a vinous one; these dry'd grapes, or raisins, boil'd in a convenient proportion of water, make a sweet liquor; which, by distillation, affords an oil and spirit, much like those of the raisins themselves: if the juice of the grapes be squeez'd out, and put to ferment, it first becomes a sweet, turbid liquor; then grows less sweet, and more clear; next affords, in common distillations, not an oil, but a spirit; which, tho' inflammable, like oil, differs greatly from it. I have likewise, without addition, obtain'd, in process of time, from one of the noblest sorts of wine, a large quantity of pure, and curiously figur'd crystals of salt, together with a great proportion of a liquor, almost as sweet as honey: and these I obtain'd, not from must, but true and sprightly wine. Besides the vinous liquor, the fermented juice of grapes, is partly turn'd into liquid dregs, or lees, and partly into that crust, or dry feculency, that is commonly call'd tartar; and this tartar may, by the fire, be easily divided into five different substances; four of which are not acid, and the other not so manifestly acid as the tartar it self. The same vinous juice, after some time, degenerates into that very sour liquor, call'd vinegar; from which you may obtain, by the fire, a spirit, and a crystalline salt, different enough from the spirit, and lixivate salt of tartar. And if you pour the dephlegm'd spirit of the vinegar upon the salt of tartar, there will be produced a violent conflict or ebullition; and often in this vinegar, you may observe, part of the matter to be turn'd into innumerable swimming animals, clearly discernible without the help of a microscope.

Into all these various schemes of matter, or differently qualified bodies, besides several others, that I purposely forbear to mention, may the water, imbibed by the roots of the vine, be reduc'd, partly by the formative power of the plant, and partly by supervenient agents or causes, without the visible concurrence of any extraneous ingredient: but if we are allow'd to add to the productions of this trans-

*Chymistry.*

transmuted water, a few other substances; we may much increase the variety of such bodies: altho', in this second sort of productions, the vinous parts seem scarce to retain any thing of the much more fix'd bodies, wherewith they were mingled; but only to have, by their mixture with them, acquired such a disposition, that in their recess, occasion'd by the fire, they came to be alter'd, as to shape or magnitude, or both, and associated after a new manner. Thus, as I formerly said, by the addition of a *Caput mortuum* of antimony, and some other bodies, unfit for distillation, I obtain'd from crude tartar, plenty of a very volatile and crystalline salt, greatly different in smell, and other qualities, from the usual salts of tartar.

I am, however, very far from thinking, that this salt is what *Paracelsus* and *Helmont* mean, when they speak of *Sal tartari volatilis*; and ascribe such great things to it. For, my salt falls extremely short of those virtues; not seeming, in its taste, smell, or other obvious qualities, to differ very much from salt of hartshorn, and other volatile salts, drawn from the distill'd parts of animals. Nor have I yet made trials enow, to be sure that it is a pure salt of tartar, without participating of the nitrous antimony. But, because it seems more likely to proceed from the tartar, than from any of the other ingredients, and because the experiment is in it self not contemptible, nor unsuitable to the present occasion, I shall set down the method I use to make it.

*A volatile  
salt of tartar,  
how prepared.*

Take of good antimony, salt-petre, and tartar, of each an equal weight, and of quick-lime, half the same weight; let these be powder'd, and well mix'd; this done, have in readiness a retort of earth, which must be placed in a furnace, for a naked fire, with a hole at the top, at which you may cast in the mixture, and presently stop it up again: this vessel, being fitted with a large receiver, must have a fire made under it, till the bottom and sides be red hot; and then, you must throw in the mixture, by about half a spoonful at a time; and nimbly stopping the hole, the fumes will pass into the receiver, and there become a liquor, that being rectified, will appear of a pure golden colour. This spirit abounds in the salt; part of which may easily be separated, by putting the liquor into a bolt-head, with a long narrow neck; for being plac'd, a little inclining, in hot sand, there will sublime up a fine salt, which, as I said, I find to be much of kin to the volatile salts of animals; since, like them, it has a saltish, not an acid taste; hisses upon the affusion of spirit of nitre, or oil of vitriol; precipitates coral dissolv'd in spirit of vinegar; turns syrup of violets immediately green; presently changes the solution of sublimate into a milky whiteness; and has several operations, like those I have observ'd in the sort of salts whereto I resemble it; and is so volatile, that, for distinction's sake, I call it *Sal tartari fugitivum*. What virtues it may have in physic, I have not yet had the opportunity to try; but I am apt to think they will not



not be despicable. A friend of mine tells me, he has done great matters in the stone, with a preparation, not very different from ours; and a very experienced *German* chymist assured me, that in a great city of his country, one has procured a privilege, that none but he, or by his licence, should sell a spirit, made almost after the same way with mine; only he leaves out the quick-lime. 'Tis also a common custom in *France*, to bury thin plates of copper in the husks of grapes, whence the juice has been squeez'd in the wine-press; and by this means, the more saline parts of those husks, gradually working upon the copper, coagulate themselves with it, into that bluish green substance we call verdigrease; of which I therefore take notice, because having distill'd it in a naked fire, I found, that by the association of the saline with the metalline parts, the former were so alter'd, that the distill'd liquor, even without rectification, seem'd, by smell and taste, strong, almost like *Aqua fortis*; and very much surpass'd the purest, and most rectified spirit of vinegar that ever I made. And this spirit I ascribe to the salt of the husks, alter'd by their mixture with the copper; because I found the latter, at the bottom of the retort, in form of a crocus, or reddish powder; and because copper is of too sluggish a nature to be forced over, in close vessels, by no stronger a heat. And 'tis, to me, remarkable, in the distillation of good verdigrease, that it never yielded me any oil, tho' both tartar and vinegar will, by distillation, afford a moderate proportion thereof. If, likewise, you pour spirit of vinegar upon calcined lead; the acid salt of the liquor will, by mixing with the metalline parts, tho' insipid, acquire, in a few hours time, a more than saccharine sweetness; and these saline parts being, by a strong fire, distill'd from the lead, wherewith they were incorporated, will, as I formerly noted, leave the metal behind them, alter'd in some qualities; whilst themselves ascend partly in the form of an unctuous body, partly in that of phlegm, but, for the greatest part, in the form of a subtile spirit, of a strong scent, very different from that of vinegar, and of a piercing taste, remote both from the sourness of the spirit of vinegar, and the sweetness of the sugar of lead.

In short, as the difference of bodies may depend meerly upon that of the arrangement of their common matter; so, the seeds of things, the fire, and other agents, are able to alter the minute parts of body; and the same agents, partly by altering the shape and magnitude of the constituent corpuscles, partly by driving away some of them, and partly by a new manner of connecting them, and others with them, may give the whole portion of matter a new texture of its minute parts, and thereby make it deserve a new and distinct name. So that according as the small parts of matter recede from, or work upon each other, or are connected together after some determinate manner, a body of a particular denomination is produced, when another happens thereby to be alter'd or destroy'd.

*Chymistry.*

Since, then, those things which chymists produce by the help of the fire, are but inanimate bodies; since such fruits of their skill differ from one another, but in so few qualities, that by fire and other agents which we can employ, we may easily work as great alterations upon matter, as those required to change one of these chymical productions into another; since the same portion of matter may, without being compounded with any extraneous body, or, at least, any element, put on such a variety of forms, and consequently be successively turn'd into so many different bodies; and lastly, since the matter, cloath'd with so many different forms, was, originally, only water, that, in its passage, thro' so many transformations, was never reduced into any of those substances, which are reputed the principles, or elements, of mix'd bodies; except by the violence of the fire, which it self divides not bodies, into perfectly simple and elementary substances, but into new compounds; I see not why we must needs believe, that there are any primogeneal and simple bodies, of which, as of pre-existent elements, nature is oblig'd to compound all others. And why may she not produce the bodies accounted mix'd, out of one another, by variously altering and contriving their minute parts; without resolving the matter into such simple and homogeneous substances as are pretended? Neither does it seem absurd to think, that, when a body is resolv'd, by the fire, into its suppos'd simple ingredients, those substances are not true and proper elements, but rather, accidental productions of the fire; which, by separating a body into minute parts, does, if those parts be shut up in close vessels, for the most part, necessarily bring them to associate after another manner than before; and so reduce them into bodies of those different consistences, that the former texture, and concurrent circumstances, render such disjoin'd particles apt to constitute. Thus experience shews us, that as there are some concretes, whose parts, when separated by fire, are fitted to be put into such schemes of matter as we call oil, salt, and spirit; so there are others, particularly the greatest part of minerals, whose corpuscles, being of another size or figure, or, perhaps, contriv'd in a different manner, will not, in the fire, yield bodies of the like consistences, but rather of different textures.

To sum up the evidence on both sides. First, we have seen, that the different substances, into which mix'd bodies have been commonly resolv'd, by the fire, are not of a pure, and elementary nature; but retain so much of the concrete that afforded them, as to appear to be yet compounded; and often to differ in one concrete, from principles of the same denomination in another: secondly, that as to the number of these different substances, it is not precisely three; because, in most vegetable, and animal bodies, earth and phlegm, are also to be found among their ingredients; and that there is not any one determinate number, into which the fire, as it is usually em-

employ'd, precisely and universally resolves all compound bodies whatsoever, as well mineral as others, that are reputed perfectly mix'd: and lastly, that there are several qualities which cannot be referr'd to any of these substances, as if they primarily resided therein, and belong'd thereto; and that some other qualities, which, tho' they seem to have their chief, and most ordinary residence in one or other of these principles, or elements, of mix'd bodies, are not yet so deducible from thence, but that more general principles must be taken in to explain them.

On the other hand, it appears, first, that several mineral bodies may be resolv'd into a saline, a sulphureous, and a mercurial part; and that, almost, all vegetable, and animal concretes, may, by a skilful artist, be divided, by the fire, into five different substances, salt, spirit, oil, phlegm, and earth; of which, the three former, being much more operative than the two latter, may be look'd upon as the three active principles; and, by way of eminence, be call'd the three principles of mix'd bodies: secondly, that these principles, tho' they be not perfectly simple, may, without inconvenience, be stiled the elements of compound bodies, and bear the names of those substances which they most resemble, and which are manifestly predominant in them; because no one of these elements seems divisible, by the fire, into four or five different substances, like the concrete whence it was separated: lastly, that several qualities of a mix'd body, and especially the medicinal virtues, do, for the most part, lodge in one or other of its principles, and may, therefore, usefully be sought for in that principle sever'd from the others.

Upon the whole, as I could make many plausible exceptions to some of the arguments I have here employ'd; so, perhaps, several of them will not readily be answer'd, by the chymists, till they alter, or reform, their hypothesis. And, therefore, if either of the two opinions, I have examin'd, or any other theory of elements, shall, upon rational, and experimental grounds, be clearly made out; I am not so far in love with scepticism, as not to leave it to embrace the truth, when it appears: but, in this case, I must say, that the inquiries of others have scarce been more unsatisfactory to me than my own.

## S E C T. VII.

**I** Formerly question'd, whether the fire be the true and proper instrument of analyzing mix'd bodies, and do but dissociate their principles or ingredients, without altering them, or compounding them a-new. But I shall now shew, that the vulgar opinion of chymists,

*That chymical principles are transmutable.*



Chymistry.

mists, as to this matter, ought to be rejected. The occasion of making the following experiments was this. An ingenious chymist told me, that by endeavouring to purify an essential oil by rectification, he found, to his disappointment, that tho' he distill'd it four or five times successively, yet it still left some feces; tho' he concluded, that if he should undergo the trouble of distilling the liquor a few times more, it would come over perfectly pure, without leaving any feculency behind it. But 'twas more agreeable to my hypothesis, that the *Caput mortuum* he complained of, was not a gross or feculent part of the oil, separated from the more pure; but a new compound produced, as other concretes also might be, by the operation of the fire. This conjecture is favoured by some experiments, I made many years before, whereby two distill'd liquors, barely from their mutual reactions, afforded a great quantity of an earthy and very fixed substance. And it seem'd agreeable to the same conjecture, that by obstinately repeating the experiment, the action of the fire upon the parts of the body, exposed to it, and their mutual operations and combinations among themselves, and, probably, too, the material concurrence of igneous particles, might produce, besides earthy feces, other bodies not unlike those that pass for the chymists principles. How far the event proved agreeable to his hypothesis, will be best gather'd from the phenomena themselves, of the tryals whereof I shall here give an account. But first I must premise, that by an essential oil, chymists mean such a fine oleagenous liquor, as, to prevent an empyreuma and feculent parts, has been distill'd with plenty of water in a limbec.

Shewn from  
the phenomena  
afforded by an  
essential oil,  
in repeated  
distillations.

Now, we took a pound of pure essential oil of aniseeds, and having put it into a glass-retort of a convenient size, we caused it to be distill'd, (in a sand-furnace, capable of giving a strong fire) thirty six times, in which train of operations, the ensuing phenomena offer'd themselves.

As pure as the essential, or the etherial oils of vegetables are presum'd to be, and as confidently as chymists pretend they are the pure sulphurs, or unctuous principles, of the bodies that afford them; yet, not only the first distillation left a substance black, like pitch, at the bottom of the retort; but, at every one of the following distillations, such a substance was either separated or generated.

Tho' after a distillation or two, it seem'd likely, that this pitchy substance would be every time less and less; yet I not only found, that at each distillation such a black substance was left; but that, now and then, a subsequent distillation yeilded much more of it than the precedent; which change, from less to more, and from more to less, was several times observed. And tho' this odd pitchy substance were, towards the latter end, found in less quantity, than at the beginning; yet the cause may well be, that the oil to be distill'd did sensibly, from time to time, decrease in bulk, by reason of the recess of that portion of the oil, which could not but be dissipated and lost in

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so many cohobations; and chiefly, by the loss of so much oil as was transmuted into pitch and other substances. *Chymistry.*

The oil appeared, in distillation, more fixed or unapt to rise than one would have expected from so fine and light a liquor; and especially towards the latter end of the distillations, it was often necessary to employ a scarce credible degree of fire, to elevate all that was not turned into pitch.

The liquor did not distil like a pure principle or homogeneous body, as quick-silver does; but first some fine and light oil usually came over, after which followed a less volatile oil, with another substance or two, and after that, another ascended in a distinct manner.

For 'tis to be noted, that besides the fore-mentioned black earth, there were produced, by the operation of the fire, several other substances, whereof the first was a waterish liquor or phlegm; which, after the oil had been exposed to some distillations, began to grow very troublesome. For being rarified by the heat of the fire into large bubbles, the incongruity between them and the oil, occasioned a kind of conflict, wherein these bubbles often suddenly broke, with great noise, and sometimes with such violence, as to shake and endanger the retort; which once, by this contest, was actually broken; yet not so, but that the liquors and other products of the fire were saved, and seasonably transferred into a new retort.

Besides this phlegm and the pitch, our operation afforded us, from time to time, a large quantity of a certain substance, which, with some, passed for a volatile salt; because it ascended to the upper part of the vessel, and appeared in a dry form, almost like short needles; and because, also, it seemed, that, like a salt, it was dissoluble in the spirituous phlegm. But tho' at first, I inclined to this opinion; yet having made some few tryals to examine the truth of it, I still am a little doubtful, whether this sublim'd body deserve the name of a true volatile salt; tho' possibly there may be much of that contain'd in it. For I found the lumps of it, notwithstanding their seeming sponginess, to sink in common water, and continue at the bottom of it, without being manifestly dissolv'd by that liquor, either in the cold, or by being kept a while in a moderate heat. I also found this substance fusible, like bees-wax, at the flame of a small taper; and if a lump of it were kindled thereat, it would burn away, partly with a yellow flame, and partly with a flame more intently blue than that of rectified spirit of wine; but it appeared apt to go out of it self.

These, and some other things, inclin'd me to look upon our anomalous sublimate, as a substance *sui generis*; yet such an one, as I suspected to be somewhat of kin to a *Sal volatile oleosum*, as camphire seems to be. For our sublimate rises without a strong fire, in a dry form, and is easily fusible; all which I have observ'd in camphire, as well as in volatile salts: and our sublimate will, like camphire, dissolve in a high rectified vinous spirit, without at all colour.

Chymistry.

colouring the liquor. And having long since found, by trial, that camphire will, tho' slowly, dissolve in good oil of vitriol, and make the menstruum look of a reddish brown; I put some of that solvent upon our sublimate; and after having left them for some hours together, tho' in the cold, the liquor seemed to have dissolved part of the dry body; having, by its action upon it, acquired a brown colour, somewhat inclining to red: and part of this liquor being put into a large quantity of common water, there seemed to emerge, by degrees, a dry body; or *flores*. But tho' I think it probable, that our anomalous sublimate may be nearer of kin to a *Sal volatile oleosum*, than to any of the chymical principles; yet I have not hitherto found the resemblance betwixt it and such a salt, to be compleat enough to make me positively refer it to any chymical product of a known denomination: and, therefore, till I am further satisfied, I shall only add, that this volatile salt, oily sublimate, or whatever name it may deserve, was very pretty to look upon; being glittering almost like some fine flowers of benzoin: and of this we had, tho' it were very light, between two and three drams.

Besides all these different substances, our oil of aniseeds afforded us, from time to time, a little quantity of spirit; as we concluded from two or three signs: one, that it came not over with the phlegm, and yet would mingle with that liquor, but not with the distilled oil: and another, that as it was more fixed than the oil and phlegm, so it rose later than they; and not only needed a stronger degree of fire, but was usually observed to come over in white fumes; as many spirits that are somewhat fixed do. And to shew more clearly, that this substance was a spirit; tho' it could not but be very much weakened, by being diffused through so great a quantity of phlegm as came over before it; yet its corpuscles were so many and vigorous, that when put upon the powder of crude coral, they presently began to dissolve it; and the phlegmatic spirit in a trice made a great ebullition, with noise and bubbles, whether I poured it on the fix'd salt of tartar, or the urinous and volatile salt of sal-armoniac.

Our experiment, therefore, argues, that a substance, looked upon by chymists as a homogeneous body, and which passes for one of their principles, may yet be of such a nature, as barely, by the further action of the fire, to yield a very considerable proportion of a substance, exceedingly different from that which afforded it. For we obtained a *Caput mortuum*, whose qualities were quite different from those of oil of aniseeds; since it was opaque, black, dry, very difficultly fusible, and fixt, in so strong a degree of fire as made the retort that contained it, and the sand about it, red hot. This substance would lie undissolved in a highly rectified vinous spirit, into which oil of aniseeds would readily have diffused it self; without the help of heat. And tho' we made the liquor actually boil, for a long time, yet most of the *Caput mortuum* continued a black substance; only



only it discoloured the menstruum, which lookt as if it had rather extracted a tincture, than made a solution properly so called. And of this black and pitch-like *Caput mortuum*, we had, at the end of our distillations, when we weighed the several parcels together, not much less than half the weight of the whole oil of aniseeds; the black matter amounting to considerably more than seven ounces. From hence we may gather, that the analysis usually acquiesced in by vulgar chymists, is as yet but an undetermined thing; since they have not declared what number of distillations shall be made the standard; by which we are to conclude, that a substance, obtained by distillation, is a chymical principle. *Chymistry.*

It may be also inferred from some phenomena of our experiment, that the fire, as usually employ'd, is not the true and genuine instrument of the analysis of bodies; since it does not barely extricate and separate the several similar substances, that, tho' concealed and disguised by mixing with each other, were pre-existent in the body exposed to its operation. For in our case, the oil of aniseeds is, according to chymists, the sulphureous principle of the concrete; and therefore, has not any other principles, especially in any considerable quantity, contained in it: yet, by the bare action of the fire, this oil, which they acknowledge to be a similar body, is brought to afford three or four other substances, of different natures from one another.

From these observations we may likewise deduce, that the fire, at least in several cases, may not only separate, but variously compound and alter the parts of a body exposed to its action; and thereby give cause to suspect, that several substances, presumed to be only extracted by the operation of the fire, may be really produced by it.

And agreeably to this, the substances obtained in our experiment, were, a fixt and earthy powder, a considerable portion of phlegm, a spirituous liquor, and a dry sublimate, a-kin to a volatile salt: and these, tho' they all proceeded from a body, that, according to the chymists, should not, and, indeed, for ought appears, did not actually contain any of them before; yet so resemble, in qualities, the earth, phlegm, and spirit, that chymists obtain by distillation from those bodies look'd upon by them as perfectly mixed and compounded, that they appear to be the same.

'Twill scarce be necessary to draw so obvious a corollary from what has been deliver'd, as, that 'tis possible for chymical principles may be made from one another.

But 'tis a considerable observation, that acid and aqueous substances, how different soever each of them is from a pure oil, may be produced from it by the action of the fire. For I found by trial, that in that liquor, which was taken for the phlegm of oil of aniseeds, there was such plenty of acid parts, that, as we before took notice,

*Chymistry.* notice, they would readily dissolve powdered coral, tho' crude, and in the cold; and would make a great conflict with salt of tartar, and with that of urine; yet the greatest part of the liquor, by far, seemed to be of an aqueous nature, which a chymist would call phlegm; that is, a body that will not mingle with oil, and is otherwise exceedingly different from oil, especially an essential one, whose purity makes it totally inflammable. And the quantity of the whole liquor, consisting of acid and phlegmatic parts, was far from being inconsiderable; amounting to about two ounces, and three quarters. It may also, be worth while to observe, that we may question, whether it be necessary to suppose, with the chymists, that nature has made provision of great quantities of primordial and simple bodies; and that she is solicitous to mix them all together, for the composing of a substance, capable of affording, by the analysis of fire, salt, spirit, sulphur, phlegm and earth. I will not hence universally infer, that there are no such substances to be found, in any of those bodies called perfectly mixed, antecedently to their being exposed to the fire; but this, I think, will follow from what has been delivered, that the pre-existence of such substances, must be made out by some other way, than the bare operation of the fire; and that the grand chymical supposition will not universally hold, that what similar body soever is obtained by the operation of the fire from a concrete, committed to distillation, was formerly and actually pre-existent in it.\*

And, lastly, our experiment affords us a considerable argument in favour of that part of the mechanical hypothesis, which teaches inanimate bodies to differ from one another, but in the magnitude, shape, motion, texture, and; in a word, the mechanical properties of the minute parts they consist of. For in this experiment, we see that oil of aniseeds, an uniform or similar body, as to sense, and judged so by chymists, upon an analysis of the concrete that afforded it, is, by having its parts variously agitated, shook, and rubbed against one another, and in differing manners broken, associated, and ranged, transmuted into four bodies of such differing natures and qualities, as the chymists principles and elements are known to be; and this, without the help of any true seed, or plastic principle, by the bare operation of the fire; or by the bare transposition of the constituent parts, guided but by so simple, impetuous, and unruly an agent, as the fire: unless it be said, that several particles of the fire substantially associate themselves with some parts of the oil of aniseeds; and concur with them to compose the pitch-like *Caput mortuum*. Tho' it will not, perhaps, be thought likely, that igneous atoms should, by their combina-

\* 'Tis proved by M. *Homborg*, that the oil of metals will pass into the substance of vegetables; and that vegetable oils will, in like manner, enter the substance of metals; that is, the sulphur of bodies

will change its state indifferently, and pass from one kind of sulphur to another, according as circumstances determine. *Memoir. de l'Acad. A. 1710. p. 312.*

tion with the particles of an inflammable oil, produce an aqueous liquor, and that in great quantity; as we lately noted of the acid phlegm of aniseeds, amounting to two ounces, and almost six drams. *Chymistry.*

Upon the whole, the phenomena observable in our experiment, seem very agreeable to the mechanical hypothesis, and very unfavourable to that of the chymists. For, whether the fire be supposed to have acted merely as an agent, or efficient cause, or to have also concurred as a material one; it appears, that by changes of texture, without the addition of any visible parts, or of any seed; bodies very different in colour, consistence, fixedness, and many other qualities, may be produced from a substance not only homogeneous, as to sense, but pure enough to pass for a chymical principle.

When I framed the conjecture, that from a chymical principle, several different bodies might be obtained, by the meer operation of the fire; I endeavoured to confirm it, by making experiments upon other distilled oils, of natures different both from the oil of aniseeds, and from one another. And, accordingly, whilst our process with this oil was carrying on, I took care to have distill'd, in the same furnace, oil of turpentine, oil of amber, and oil of hartshorn.

*Phenomena in the repeated distillations of other chymical oils.*

These oils were committed to the same person, who managed the oil of aniseeds; and he, accordingly, kept a kind of journal of the number of rectifications, the quantities of pitchy matter, from time to time, afforded by them, and other phenomena, or circumstances, that occur'd in so tedious a prosecution, as I thought experiments of such moment deserved. The substance of this journal is as follows.

Two of these three oils, that of turpentine, and amber, and, probably, the third also, were distill'd at least fifty times.

Each of the three left, from time to time, in the bottom of the retorts, whence they were drawn, a considerable quantity of black feces, much like those left by the oil of aniseeds. I, long after, found, in a paper, some of this matter left by the oil of turpentine; and, tho' I am not certain, whether it were all that was afforded by the pound of oil we employed, yet it amounted to above two ounces and five drams: and the other two oils did each of them afford a considerable quantity of black terrestrial matter; tho' my assistant observed, that the oil of hartshorn sooner ceased to leave copious feces, than the oil of turpentine, or that of amber. But if neither of the two afforded any more than did the oil of turpentine; I look upon it as a remarkable thing, that the oil of aniseeds, which is a fine essential oil, distill'd in a vesica, or limbec, should yield above twice more of earthy matter, than any of the three other oils, that were distill'd but in retorts.

Of the colour of the rectified oil of hartshorn I can say little, having unluckily lost the liquor it self; but the oil of amber, after the one and fiftieth distillation, was, indeed, very clear, yet of an amber colour, far from pale: and the oil of turpentine, that is usually after



*Chymistry.* one rectification, a clear and colourless liquor, after fifty distillations, appeared almost red.

But that is much more considerable, which I observed in the quantities of the different liquors, afforded by the long series of our distillations; for at the end of the process, the remaining oil of turpentine, for instance, did not appear to be considerably, if at all, superior in bulk to another liquor, that came over with it in distillation, and was not true oil; for it would readily enough mix with water, but keep it self in a mass distinct from the oil; and weighed above three ounces and three quarters.

This odd liquor I looked upon as compounded of spirit, and of phlegm; for tho' the latter did so much exceed the other in quantity, that with an expert chymist, the whole liquor passed for phlegm; yet I not only judged some parts of it to be spirit, but found them of an acid nature too; since, besides what the taste made me suspect, the compound liquor would readily begin to corrode beaten coral, even in the cold; and some of it being poured upon good salt of tartar, presently made with it a conflict and ebullition, not without a hissing noise, and a multitude of bubbles. So, likewise, the spirituous phlegm of amber, made a conflict with salt of tartar, and dissolved crude coral, as other weak acid spirits do. This liquor of amber was not pale, as the phlegmatic spirit of oil of aniseeds; and that obtained from the oil of turpentine was high-coloured, being of a brownish red.

And among other trials made to examine, whether the spirits afforded by our oils, were really acid; we put two ounces of the spirituous phlegm of oil of aniseeds, upon some minium; and, having digested them a while together, found the liquor turn'd sweet, and fit to make *Saccharum Saturni*: and this liquor, after filtration, being gently abstracted, left in the bottom of the retort, a thick, honey-like substance; from which (the distillation being continued with a much stronger heat) there came over some liquor; but being in too little quantity to be rectified, we could not free it from its phlegm, and, therefore, did not find it inflammable; as I guessed the spirituous part would have been after rectification; because the liquor was exceeding like the *Spiritus ardens Saturni*, in its peculiar, and very penetrating taste and smell.

Two vials, one containing some of the oil of turpentine, and the other some of the oil of amber, each of them distill'd at least 50 times, having stood above a year and half to defecate; I was willing to try, whether these liquors would still yield such a black substance as before; and causing each of them to be again distill'd in a retort, they left a greater quantity of a black and shining substance, than could well have been expected.

It may seem very odd, that so volatile and thin a liquor, as a chymical and rectified oil, should, by the bare operation of the fire, be brought

brought to yield a great quantity of what appears so like terrestrial feces, as our pitchy *Capita mortua*. For having put one ounce of the *Caput mortuum* of the oil of aniseeds, and as much of that afforded by oil of turpentine, each of them into a distinct crucible, and kept them for near four hours, in such a heat, as made the vessels all the while red hot; tho' the crucibles were not closely covered, yet we found, when the vessels were removed from the fire, that the contain'd bodies had not at all been brought to fusion; only that from the oil of aniseeds, was, in part, somewhat caked together: and, notwithstanding all the heat they had been exposed to, the pitchy substance of the oil of turpentine, retain'd near three quarters of its first weight; and the *Caput mortuum* of oil of aniseeds lost about eighteen grains less than that.

After this, we also endeavoured to discover, whether our pitchy substances would afford any fixt or alkaline salt, as the *Capita mortua* of most bodies belonging to the vegetable kingdom do. But tho' we kept an ounce of each of the black substances, left by the oil of aniseeds, and that of turpentine, for nine or ten hours, red hot, in crucibles, we found, indeed, the bodies very much diminished in quantity, but not at all calcin'd.



# EXPERIMENTS AND OBSERVATIONS

Upon the producibleness of  
CHYMICAL PRINCIPLES.

## SECT. I.

**T**HE pompous title of hypostatical principles, which chymists have bestowed upon the ingredients whereof they would have mix'd bodies to consist, has, perhaps, procured them a veneration from vulgar heads: but what principally recommends their doctrine to discerning men, seems to be this; that as by the help of a few, original, simple ingredients, join'd in different proportions, all mix'd bodies may be compounded; so, the natures of a multitude of them, seem, by this means, discoverable, from first knowing the natures of a few. He, therefore, who is unsatisfied with this hypothesis of the *tria prima*, or that which also takes in water and earth, can scarce attack it more forcibly, than by calling their grand assertion in question, and inquiring, whether these pretended principles are ingenerable and incorruptible; and whether nature only compounds and dissociates, without either producing or destroying them. For if the bodies they call principles be produced *de novo*, how is it demonstrable, that nature was obliged to take those made ready to her hand, in order to compound a mix'd body? And how will it appear in every analysis made by fire, that the salt, for instance, thereby obtain'd, was not produced from the chymical operations, but pre-existed in the body, in minute parts; (which, by the action of the fire, were only extricated and separated from the other principles or ingredients, and afterwards brought together;) since, in case the chymical supposition be erroneous, not only the salt thus obtain'd,

*The chymical  
principles not  
ingenerable  
and incorrupt-  
ible.*



obtain'd, may be, in part, due to a new production, or transmutation, but some of that which was really salt, if any such thing there were antecedent to the analysis, might be either destroy'd by the operation, or made to appear under another form? Chymistry.

Salt seems to be the leading principle with the chymists; and 'tis generally granted, that salts are the most considerable and active parts obtain'd by chymistry, from mix'd bodies; tho' the invisible particles, that compose the visible portions of a salt, may, perhaps, be such, and so contriv'd, as to make other parcels of matter, which shall have those qualities, on account whereof, the chymists call a body sulphureous, or mercurial; as may be instanced in the inflammability of nitre. 'Tis therefore proper to enquire, whether salt, indefinitely speaking, may be produced *de novo*, or destroy'd; and whether, at least, the particular, and very different species of salts, may be chang'd into one another, and thereby, after a manner, be produced, in regard to the acquir'd species of salt; and destroyed in relation to that, which the same portion of matter before belong'd to.

*That salts may be produced and destroy'd.*

Now, I must here observe two things; first, that as salts differ greatly in several properties, some being fix'd, others volatile, some acid, others urinous, &c. the two qualities, wherein they agree, and which, therefore, make up the receiv'd notion of salt, in general, are, that it is easily dissoluble in water, and that it affects the palat, so as to cause the sense of tast. And secondly, whether we allow the *Epicurean* hypothesis, or the *Cartesian*, the first saline concretions, produced by nature, must have been made of atoms, or of particles, that, before their conjunction, were not saline; and therefore, there is no absurdity in conceiving, that by the action of the fire, or other fit agents, small portions of matter may be so broken into minute parts, and these so shap'd and connected, as, when duly associated, to compose a body, capable of dissolution, in water, and of affecting the organs of tast.

That a disposition to be dissoluble in a liquor, may be acquired by mixture, and a new texture of parts, appears from hence, that tho' powder'd sulphur will long lie in well rectified spirit of wine, without being at all visibly dissolv'd therein; and tho' the same liquor will, for as long a time, swim upon salt of tartar, without making a solution of it; yet if the salt, and sulphur, be mix'd together, the same spirit of wine will, in less than an hour, dissolve enough of them, to be highly colour'd thereby, even without the help of external heat. Why then should it be impossible, for the fire to reduce the corpuscles of bodies to such a minuteness, and associate them either among themselves, or with the corpuscles of other bodies (which, before preparation, will not dissolve in water;) so that the pores, intercepted between them, may be enter'd, and their loose texture dissolv'd by that fluid? Crystals of well purified salt-petre, may be kept dry, for many months, in an ordinary chamber; yet, if without the addition of any body,

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body, dissoluble in water, or the moist air, it be, in part, reduced, as perhaps it may be almost in a trice, to a fix'd alkali; this salt will be easily penetrable by the vapours that float in the air, and by this moisture soon be brought to relent, and at length, to dissolve into a liquor analagous to *Oleum tartari per deliquium*.

As for the sapor of a saline body, I doubt, whether the necessity of it be consistent with another principle, and with experience. For even those pure oils, called essential, or etherial, are highly sapid; yet as these will not dissolve in water, there appears to be no strict connection betwixt being sapid, and being soluble in that fluid: whence, if bodies be reduced into a multitude of parts minute, and sharp enough; 'tis very possible, that some of them may acquire a shape and size that fits them, sensibly to affect the organ of tast, tho' the bodies themselves are rather of another nature, than of a saline one. Thus a ball of glass, while entire, will not hurt the skin; but pricks it, and causes pain, if broken into little sharp fragments. And the like, perhaps, may happen in the organs of tast: for salt-petre, tho' it have but a faint and languid tast; yet if carefully distill'd, with an addition, not dissoluble in water, and insipid; the parts of it being, by the action of the fire, broken asunder, rubb'd, or ground against one another, till they are reduced to edged and pointed corpuscles, will be resolv'd into different substances; each whereof has an extremely strong and piercing tast. Now, whence this should proceed, but from such a mechanical change, as we have describ'd, is not easy to say: and, perhaps, also, the watry liquor, that comes over in this analysis, may be produced by the operation of the fire; and the phlegm being insipid, so much tast as was in the entire nitre, may be as well destroyed, as those of the spirit and alkali are generated by the same agent. But, perhaps, there needs no other argument to shew, that the same parts of matter, according to its different states, may have the qualities which chymists attribute to their particular principles, than our observation upon chymical oils, which more strongly affect the tast, than most salts themselves. And *Helmont* assures us, that by *Paracelsus's Sal circulatum*, solid bodies, among which he particularly instances stones, may be transmuted into actual salt, equal in weight to the body whereof it was made. So that, as the chymists suppose, there is in these mix'd bodies, sulphur, mercury, and a *Terra damnata*; the same portions of matter that pre-existed in the form of those simple ingredients, must, by the operation of the fire, and an anomalous menstruum, have been turn'd into salt: and if the *Helmontian* experiment be allow'd good, we may safely conclude, whatever becomes of the chymical supposition, that salt may be made of matter which was not salt before, and consequently, that salt may be produced *de novo*.

The salts, properly so call'd, that appertain to our present enquiry, seem to be chiefly the acid ones; such as vinegar, spirit of salt, &c. the alka-

alkaline or fix'd lixivate salts, made by calcination; such as salt of tartar, of wormwood, &c. and lastly, the volatile and urinous salts, such as those of harts-horn, of urine, of blood, &c. which taste and smell, like that of urine. If, therefore, we can shew, that these may be produced *de novo*, or transmuted into one another, we shall prove the common chymical doctrine of principles false.

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To begin with acid salts; we see that even sweet wines often, of themselves, degenerate into sour vinegar, which will dissolve coral, several stones, calcined lead, and other minerals. The water imbibed by the roots of trees, is, in those that bear lemons and barberries, changed into liquors abounding with saline corpuscles, that enable them to affect the organs of taste, and act as acids on pearls, &c. Guaiacum, also, and several other woods, that do not taste at all sour, will, by being distill'd in retorts, afford spirits plentifully furnished with acid particles, which, as I have tried, hiss upon alkali's, dissolve coral, and even lead it self, calcined into minium, and make *Saccharum Saturni* of it. Many other vegetable bodies, also, do, without addition, afford the like acetous liquors. If it be objected, that these pre-existed in the bodies whence they proceeded, and were only extricated by the operation of the fire; I expect that this should be prov'd; for the sweetest bodies, and those of different kinds, as sugar and honey, afford a sort of spirits, which are sharp and piercing. And in several cases, where we are sure that acid spirits were plentiful ingredients of a composition, as in *Saccharum Saturni*, and that magistery, called salt of coral, &c. experience shews, that the liquor which comes over, by distillation in retorts, is not acid, but quite of another kind. I would not hence be concluded to deny, that acid salts may in some mixed bodies, be so associated with others, and obscured by them, as not to be discernable to the taste, till they are separated by the operation of the fire. But to shew, that acid salts were *de facto* pre-existent, as acid ones, in the body that affords them, there must be some positive proof, other than the liquors distill'd from them; since they, as we have already argued, may be not barely extricated, but have their acidity produced by the operation of the fire. And saltpeter, tho' it have no acid taste, may be made to afford, by distillation, above three quarters of its weight of a highly acid liquor; yet it appears not, that such a great proportion of acid particles, or possibly any considerable proportion at all, is employed, by nature, in the composition of nitre. Nor ought it to seem incredible, that acid salts, as well as others, shou'd be producible by the various separations, attritions, coalitions, and changes of texture, which may be caused several ways; and especially by the operations of the fire, that makes a vehement and various agitation of all the minute parts of a body, and may therefore easily split or break some of them, and, as it were, grind others against one another, and in short, so alter their bulk, figure and motions, as to make them fit to stab or cut

Shewn in the acid kind.

the



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In the volatile.

the tongue, and the other bodies they work on, after the manner of those substances we call acid.

We have an eminent instance of the production of volatile salts in the salt obtainable, by distillation, from soot; for tho' the wood we burn in our chimneys, seems to have nothing of the taste, or smell of urinous salts; nor the dissolutions of the saline parts of such wood been observ'd to have any affinity, in taste or odour, with the salt of soot; yet when wood is first burnt in the fire, and then the soot afforded by it, duly distill'd and rectified in proper vessels, there is obtained a spirit, and a white volatile salt, that in smell, and taste, and several operations, appear to be nearly allied to those of human blood, or urine, and may easily be mistaken for them.

But this double operation of the fire is not always necessary to the productions of volatile salts out of vegetables; for tho' by distilling them in retorts, we generally obtain no dry salt, but a sourish spirit, with which I have dissolv'd coral, lead, and other hard bodies, that urinous spirits wou'd not work on; and tho' being put upon urinous salts, they make a great hissing, and conflict; yet I have from mustard-seed, that had been kept for a convenient time, obtained, by distillation, a volatile salt that fastened it self prettily, in figured grains, to the upper part of the receiver, and this at the very first distillation; so that there was no need of rectifying the distill'd matter to separate that salt. And by an easy way we may, out of very many vegetables, first duly prepared, without adding any thing to them, by bare distillations in retorts, obtain plenty of volatile spirits and salts, which, by their fugacity, colour, smell, taste, &c. prove so like the salt and spirit of urine, soot, &c. that he who knew nothing of the manner wherein they were made, wou'd readily conclude they belong'd to one or other of those sorts of bodies.

I have, also, sometimes produced a volatile salt, which wou'd readily be pronounced urinous, from a mineral it self; nor was this the only fossil from which experience assures me, salt of this kind is obtainable.

It is not universally true, that saline substances, which appear volatile, and ascend in the form of salt, are of an urinous nature, and enemies to acids. For I have had from verdigrease, distill'd *per se*, with a strong fire, a very acid spirit, which being warily rectified, afforded first a sour phlegm, and then a piercing spirit, sharper than it; leaving behind, in the vessel, some few spoonfuls of a dark colour'd liquor; which, being set aside, and suffered to rest, did, in great part, shoot into transparent crystals, large, thin, and almost like those of silver dissolv'd in *Aqua fortis*: they appeared prettily figured at the edges, but were so oddly connected among themselves, that I could not refer them to any of the known geometrical figures; and their brittleness made them the less tractable; but their smell, which was

strange.

strangely piercing, and not inoffensive, argued them to be of the same nature with the acid spirit which had come over with them. *Chymistry.*

But there is a more constant and easy method of producing such a volatile salt; for, if amber be gradually and carefully distill'd, it will afford, besides the phlegm, spirit, and oil, a dry substance; which, tho' the chymists call the volatile salt of amber, I found to be really of an acid nature, upon several of those trials, by which we discern a body belongs to the family of acids.

The last sort of salts to be shewn producible, are the alkaline, or fix'd, which seem opposite to acid ones; making a conflict with them, and performing several operations contrary to theirs. *And in the alkaline, or lixivious.*

As to the origin of these fix'd salts of calcined bodies, the chymists are not of one mind: the most universal opinion, before *Helmont's* time, and even of later chymists, seems to have been, that these fix'd alkalies pre-exist in mix'd bodies; and that the fire only separates, or extricates them from the parts of the compound. But *Helmont* has ingeniously conjectured, that these lixivate salts do not pre-exist, in their alkaline form, in the bodies that afford them; but are productions of the fire, by whose violent action, a part of the salt, which, in the concrete, is naturally all volatile, lays hold of some parts of the sulphur of the same body, and so, both together are melted, and fix'd into an alkali; which fixation he exemplifies, by what happens when salt-petre and arsenic, tho' both volatile, being exposed to the fire, are, by its operation, flux'd, and made to fix each other. But I doubt, whether this account be clear and satisfactory; especially if 'tis applied to all fix'd alkalies. For it may be question'd, whether it has yet been prov'd, what *Helmont* teaches, that all the salt of mix'd bodies, before their combustion, is volatile: nor is it declared what volatile salt is meant; tho' it be plain, that some bodies, which afford a fix'd salt, abound in acid spirits, as oak, box, &c. and others, as hartshorn, blood, &c. abound in urinous salts, that exercise hostility with acids. And from some bodies I can obtain both acid spirits, and such as are called urinous. 'Tis not easy to explain, how the volatile salt comes to unite it self so intimately with the oil; and, tho' this be also volatile, to compose with it a body able to endure the violence of the fire; since we have more than once try'd, that the volatile salt of urine, or of hartshorn, and a chymical oil, as of turpentine, or the like, being put together, the salt will, indeed, associate to it self some particles of the oil; but will, nevertheless, with them sublime, by a very gentle fire, in the form of a salt. And the example that *Helmont* gives of arsenic and nitre, seems unsatisfactory; because, upon mixing equal parts of those two bodies, and, in a strong crucible, fulminating them together, a great part of the mixture was driven away by the fire, so little alter'd, that 'twas very dangerous to be too bold with the fumes; and a large part of what remained, was fix'd only in comparison of the crude arsenic, but not comparably to salt of tartar, or other true alkali: and the constancy of the part that was more fixed, may, probably,

*Chymistry.*

bably, be ascribed to the salt-petre; which we know will, without the help of arsenic, afford a great deal of fixed salt, if about half of it be burnt away by the help of powder'd charcoal, or some other convenient ingredient. It also weakens this instance of *Helmont's*, that there are other instances in which we observe no such thing happen, as his hypothesis would make one expect. For, common sulphur is by chymists said to abound in an oily part, upon whose account it is very inflammable; so that they would have other inflammable bodies to hold that property, by participating of sulphur. That this concrete, also, abounds in salt, is evident, according to their principles, by the acid menstruum it affords, which goes under the name of *Oleum sulphuris per campanam*. Yet these ingredients, combined by nature, make up a concrete, which both in close vessels, and the open fire, is almost totally volatile. And in that mixture of the highly dephlegmed spirits of wine, and of urine, that *Helmont* calls the *ossa alba*; tho' the urinous salts manifestly combine with the spirit of wine, which, being totally inflammable, the chymists refer to their sulphur; yet the coagulated part does not, by this association of ingredients, grow fixed, but proves very volatile. It might here be urg'd, in favour of the common opinion of the pre-existence of alkalies in mixed bodies, first, that there is no need to suppose a colliquation of salts, with sulphurs, oils, or any thing else, to produce fixed salts; since that supposition does not explain, how two volatile bodies come to compose one that is fixed; and since 'tis plain, that a body yet more fixed, may be made without any association of different principles. For, the earth, that, together with the alkali, remains in the ashes of a burnt body, is more fixed than the alkali it self; and yet derives not its fixity from any combination of elements, or principles, but from the grossness, solidity, or weight, and unsuitness for avolation, in the corpuscles it consists of. Secondly, some instances are alledg'd, wherein there is supposed a diminution of the quantity of the fixed alkali of the concrete, by operations that are said to carry off the volatile salt, before the body comes to be incinerated. But, it may be answer'd, that, perhaps, those various operations did but rarifie and volatilize part of the pre-existent alkali, and so left the less of it to be recovered by calcination; as, the chymists tell us, fermentation rarifies the oily parts of the juice of grapes, and subtilizes them into vinous spirits, and so, greatly lessens the quantity of the oil. And thus, when wood is burnt in a chimney, 'tis not in the form of an acid salt, which is the only one commonly observ'd to be driven away by distillation in close vessels, but in the form of an urinous salt, that the saline part of the wood is made to ascend; as may appear by the distillation of foot. But instead of insisting on these arguments, we need only observe, that tho' by distillation, or any other known way of treating salt-petre, there is no oil to be separated from it; yet above half the body of it may be easily and quickly turn'd into a fixed salt, in colour, tast, and operation, much like that of tar-



tartar, and other incinerated vegetables. And such an alkali I have made, without the help of injected coals, or any other body furnished with a combustible sulphur; so that it seems not universally true, that to the production of an alkali, there is necessary to be at hand, an oil or sulphur, to be laid hold on by the volatile salt, and fixed together with it. But this experiment is far more agreeable to our doctrine, which derives all those salts from the size, shape, and solidity, or weight of the saline corpuscles; since the same salt-petre, whose greater portion, by the foresaid operations, will be reduced to a fixed alkali, may, by being distill'd with a convenient bole, have its greater portion brought over in the form of an acid spirit, or salt; which it self may afterwards be made to concur, materially, to the production of an alkali. I might add, that even from one of *Helmont's* own experiments, this conclusion follows; for he affirms, that by the addition of more alkaline salt, and the operation of the fire, the earth it self that is in the ashes, may be turn'd into salt: which, if true, argues, that a fixed salt may be made of what was not before either of a saline, or of an oleaginous nature; and, consequently, without any such combination of salt and sulphur, as his hypothesis supposes. From this experiment I may, also, infer the possible origin of alkalies, by the mechanical changes, that, without the addition of oil or sulphur, the operations of the fire produce in the parts of a mixed body; since earth seems the most indisposed of any part of the concrete, except water, to be turn'd into fixed salt.

I must not here omit an observation I have made, which seems to overthrow the opinion of those, who will have the violence of the fire to be always a necessary agent in the production of a fixed or lixivate alkali. Having some salt, sent for a present out of the *East*, to a nobleman, who had been ambassador for his *British* majesty at the *Ottoman* court, and affirm'd to be the true *Egyptian* nitre, so much talk'd of by the ancients; I found it to agree much better with the notion books had given me of it, than with that sort to which chymists generally give the name of nitre, and which, indeed, is the only nitre to be usually met with in our shops.

This salt, I found, was very apt to imbibe the moist air, as calcin'd tartar, and other fixed alkalies are. But what makes to our present purpose was, that having upon this crude *Egyptian* nitre poured spirit of salt; the acid liquor presently, even in the cold, work'd briskly upon it, as if it were a fix'd alkali. And hence, by the way, we see the justness of that expression of *Solomon*, when, to represent things very incongruous to one another, he mentions the disagreement of vinegar and nitre; for presuming that *Solomon*, who reigned in *Judea*, a country near to *Egypt*, and had much commerce with the *Egyptians*, made use of their nitre, as the best, if not the only sort known in his time and country; and finding that nitre is mention'd by the prophet *Jeremy*, as a very absterfive thing, and fit to cleanse womens skins, which is a

*Chymistry.*

*Egyptian nitre, a native lixivious salt, or alkali.*

*Chymistry.* known virtue of fix'd alkalies, but no more than the former observ'd in common salt-petre; I pour'd upon it some strong vinegar, and found, as I expected, that there presently ensued a manifest conflict, with noise and many bubbles. Hence it appears, that *Egyptian* nitre, acknowledged to be a native salt, and made only by the evaporation of the superfluous water of the *Nile*, is yet of a lixivate nature, or, at least, abounds with particles that are so; tho' produced without precedent incineration, and the matter of it expos'd to no violence of the fire, to make it afford an alkali.

I pretend not, however, to say, that alkalies may not be produced in multitudes of mix'd bodies, especially in many vegetables, after the way proposed by *Helmont*. It will suffice, for my purpose, if some bodies, belonging to this family, or kind of salts, may be produced at all. And, tho' I do not assert, that all fix'd alkalies are productions of the fire, or made by the help of it, yet I do not remember any, except *Egyptian* nitre, but what are.

An alkali  
made from  
sea-salt.

*Chymists*, generally, look upon spirit of nitre, and *Aqua fortis*, as containing not alkaline, but acid salts; which they conclude from the taste, as well as from the great ebullition that is made, when those liquors are pour'd on salt of tartar, fix'd nitre, pot-ashes, or other unquestion'd alkalies. That sea-salt, likewise, contains no alkali, is generally allow'd; the spirit of it being justly reckon'd among the acid ones: and when I purposely examin'd that concrete, by distillation, the remaining salt, tho' the fire had been violent, was very different from alkalies; yet, I, several times, made the following experiment with sea-salt, that retain'd all its acid spirit. Upon well-dry'd, and powder'd sea-salt, plac'd in a retort, we pour'd sometimes an equal, and sometimes a double weight of good spirit of nitre, or *Aqua fortis*; and leisurely distilling all that would come over, we took out the dry salt, remaining at the bottom; which we found much chang'd, both as to colour and taste. This salt, being again powder'd, and put into a crucible, placed in a convenient fire, was, by the repeated injection of well-kindled charcoal, made to flash several times, almost like melted nitre; and when it would flash no longer, the remaining matter, being taken out, did, in great part, appear of an alkaline nature; for it had a fiery taste; and if spirit of nitre, or *Aqua fortis*, were poured thereon, it would make an ebullition: it turn'd syrup of violets green, and, in short, exhibited various phenomena of alkaline salts.

Others from  
salt-petre.

There is another way of making an alkali out of nitre, thus: pour upon it an equal weight, or half the weight, of strong oil of vitriol; and having diluted the mixture, with a convenient proportion of fair water, distil it, by degrees, till there remain a very dry substance; powder this, and mix it well, with about an eighth part of beaten charcoal; keep them in fusion, in a strong close crucible, till the mass grow very black, and a little of it being taken out, with a wire, taste.

tasts fiery; then, take out the mixture, which will very easily imbibe the moisture of the air, and you will find it, at least while 'tis hot and dry, of a more fiery lixivate tast, than salt of tartar it self. It will make an ebullition with acid spirits, and precipitate several solutions made with them; it will turn syrup of violets green, and, in short, discover it self, many ways, to be of an alkaline nature; tho' it be associated with a sulphur, that may, by various methods, be made appear to be plentifully contain'd therein.

It is, also, remarkable, how the same body, without the addition of any other salt, may, by varying the manner of the fires application to it, be made to afford either little else than acid salts, or a lesser or greater quantity of alkali. For, if fine salt-petre be dexterously distill'd, with about thrice its weight of some proper earth, not powder'd bricks, it will, sometimes, afford very near as much spirit of nitre, as the salt weigh'd; and tho' this, like other liquors, be not without phlegm, yet it may be doubted, whether most of it were not produc'd by the transmuting operation of the fire: however, we may suppose, that five parts of fix, or six of seven, have been distill'd into dephlegm'd spirit.

But, if by frequent injecting into flux'd salt-petre, small pieces of kindled charcoal, till it will flash no more, fix'd nitre be made; you may obtain therefrom, half its weight of an alkaline salt, that many would, by its tast and operations, guess to be salt of tartar.

But, farther, to shew, how much the production of this alkali depends upon the operation of the fire, which, as 'tis variously applied, may vary the texture of the salt-petre; I made the following experiment. We took a pound of good salt-petre, grossly beaten, and having laid it in a conical heap, upon a flat tile, that the air might, on all sides, have access to it, we caus'd the upper part of it to be kindled by a little fragment of burning coal; then, with an iron rod, we dexterously stirr'd the kindled part of the nitre, that the ignition might, presently, be communicated to as many parts of the salt as possible: and this nimble agitation of the mass, was continued to the end of the operation; by which method, within few minutes, we obtain'd, more than once, out of 16 ounces of salt-petre, 10 ounces of fix'd nitre, very lixivial in tast and operation, and of a pleasant greenish blue colour, deeper than salt of tartar will usually be brought to, by being, in a crucible, kept twenty times as long in a strong fire.

This experiment shews what quantity of alkaline salt is, by a different operation of the fire, obtainable from crude nitre; which, in a distillation, skilfully made for the purpose, may be, in great part, driven over in the form of acid spirit and phlegm, so as to leave a surprizingly small quantity of true alkali behind it. Nay, sometimes, I could scarce find any at all, tho' I purposely try'd to separate it from the tobacco-pipe clay, wherewith the salt had been mix'd; and this,



*Chymistry.*

this, after a distillation, wherein not half of the nitre had been driven into the receiver in the form of spirit.

And, to shew, that to make the fix'd salt of nitre, the actual inflammation of it in the open air, is not necessary; and that 'tis possible to make an alkali of nitre, tho' no combustible body be added to kindle the corpuscles of the salt by its sulphur; and, by the association of some part of the sulphur, with the saline parts of the nitre, to compose an alkali; I more than once, with a convenient quantity of good salt-petre, carefully mix'd about an eighth part of tobacco-pipe clay, and putting the mixture into a crucible, closely luted at the top, we kept it, by a graduated fire, in fusion for some hours; and found, that the remaining salt was turn'd into an alkali, of a fair blue colour, like the better sort of that fix'd nitre, which is made with charcoal. These two experiments seem plainly to argue, that to the making of fix'd nitre, which is confess'd to be an alkali, a proper change of texture may suffice; whether that change be attempted in open vessels, or in close ones, with, or without the addition of the sulphur of charcoal, or any other combustible body. I, also, successfully attempted to make an alkali of salt-petre, by melting moderate quantities of it, several ways, and keeping it in fusion, with some metals. And to obviate the suspicion, that some chymists might have, of the material concurrence of a large portion of the combustible sulphur, presum'd to be in the ignobler metals, to the production of the nitrous alkali; I shall add, that our experiment succeeded, when we made it, more than once, with very fine silver, whose sulphur, if it have any, is granted to be fix'd, or incombustible. And, I remember, the last trials afforded us a bluish alkali, tho' there were employ'd a fifth part of silver in proportion to the nitre; and tho' the fire was so moderate, as not to melt the metal, that was in thin plates: and of an ounce put in, there wanted but four grains; which small loss, might well be imputed to accidents.

*Alkalies  
transmutable  
into other sub-  
stances.*

And as lixivate salts, and alkalies, may thus be produced, by the operation of the fire; so, may they be destroy'd, or depriv'd, of their alkaline form, and turn'd into a substance of a nobler nature, by the same. We took a tolerable quantity of a good salt of tartar, that had been purified by solution and coagulation; and having put it into a clean crucible, we kept it in a strong fire, that made the crucible red hot, for a considerable time; then, at length, giving it a stronger fire, we poured it out, and again dissolv'd as much of it as we could in cold water, which being set to run thro' cap-paper, there appear'd in the filtre, a moderate quantity of matter, that would not dissolve in the water, but was turn'd into a kind of earthy substance; then re-coagulating the solution, that had pass'd thro' the filtre, into dry salt, we again expos'd it in the crucible to a strong fire; and putting it into fresh water, we perceived it would not totally dissolve, but left, in the filtre, a slime, or mud. And, in this manner, we proceeded

ceeded to ignite, dissolve, filter, and coagulate the same salt of tartar for sixteen times, and still found such an earthy substance remaining in the filtre; and the rest of the salt of tartar so little altered, that I concluded it highly probable, the remaining part might, by the same way of management, be brought to yield more and more of that same substance, which either was earth, or of kin to it; being somewhat of a nature very different from salt of tartar; since it was not fiery on the tongue, and indissoluble in water.

*Chymistry.*

It may illustrate, and add probability to what we have said about the producibleness of salts, to consider the composition and re-composition of saline particles, and their operations on other bodies, and on one another. For if it appear, that by these manifest and mechanical ways, such alterations may be made, and such qualities produced, as are either altogether, or very near as considerable as those which discriminate the several families of salts from one another, and from the chymical principles, it will be judged the more credible, that these families of salts may be either transmuted into one another, or otherwise produced.

To shew that common salt it self, which seems the most primitive and simple among gross and visible salts, may be produced by a change of texture made in bodies very different from it; I shall recite an experiment, which tho' it have sometimes failed me, yet it has often answered my desire.

*Common salt producible.*

Sandiver is a recrement made when, the materials of glass having been first baked together, and then kept long in fusion, the mixture casts up the superfluous salt, which the workmen afterwards take off with ladles. This salt, tho' seldom used by mineralists, and scarce mentioned by the writers of courses in chymistry, I have employed to several purposes. For herein we have a salt, which was once altogether lixivate; and which, by being kept long melted in a strong fire with the sand, must have had its saline corpuscles variously and forcibly ground or rubb'd against one another, and against the particles of the sand; some of which it may also dissolve and retain: however, by these rude justlings and mutual attritions, I thought it very probable, that the alkali must have been variously and considerably altered; so that sandiver may consist of portions differently qualified, both with regard to the lixivate salt that was at first employed, and to one another.

We dissolv'd a considerable quantity of good sandiver in fair water, filter'd the solution, and set it to evaporate in a digestive furnace, till a saline crust spread it self upon the top of the liquor; then suffering it to cool and crystallize, we broke that crust; to come at the crystals, and set the liquor, we had poured off from them, to evaporate further, and shoot again; and in this method we proceeded as long as we thought proper: by this means we obtained many crystals, whose figures were not the same, tho' most of them transparent.

*Chymistry*

parent and prettily shap'd; but the chief thing for which I mention this experiment is, that by proceeding thus, I more than once obtained, not on the very surface of the water, as is usual in the concretions of sea-salt, but in other parts, and chiefly beneath the surface of the saline crust, a considerable number of grains of salt, that better answered to the description of common salt than dissolv'd and filter'd sea-salt it self; for these grains were large, and as like little cubes, as if they had been made by a skilful jeweller; and their surfaces had a smoothness and gloss much surpassing what I had ever observed in common salt.

I may confirm the difference I have mentioned, to be between sandiver and common alkalies, by this, that having set a large quantity of the filter'd solution of sandiver to coagulate in a cool place, and thereby brought a great part of the salt to coagulate into crystals, almost like those of nitre, but so very diaphanous, that several of them were clear as rock-crystal; I did not observe them to relent by the moisture of the air, in a long time, tho' the glass they were kept in, was negligently covered with paper only: which argues their texture to have been remote from that which is proper to alkalies; and shews them to be, also, salts of a peculiar nature. If they were exposed to a gentle heat, they would, in no long time, lose their transparency, and be reduced to a fine white calx, which being weighed, and again dissolv'd in water, and made again to crystallize, would be transparent, and coagulate with it self so much of the water as gave a very notable increase of weight.

Sandiver is by some reckoned an artificial body; my second instance, therefore, shall be in a body that seems natural. If human urine, after having been kept for some weeks in a closed vessel, be exposed to a moderate fire, it will first yield a spirit and a volatile salt, then a large quantity of phlegm, which being totally exhaled, there will remain a dry *Caput mortuum*; and this being warily calcined, dissolv'd in water, and coagulated, if the experiment succeed, you will find the salt very different from a common lixivate alkali; or rather, the saline concretions will differ in form, if not in kind; for I observed some to be oblong, and to look like small crystals of nitre, but others rhomboidal; and one of the fairest of the latter, I kept, for many days, exposed to the air; and that in winter, without finding it run *per deliquium*; as a piece of common alkali of that bigness wou'd have done, in a small part of the same time. But besides those numerous saline concretions that I cou'd not easily reduce to any known figure, there was a considerable number of fine grains, resembling common salt; and were, indeed, more exactly cubical in their figure, than the grains of sea-salt. And I have the less cause to doubt, that the sea-salt, abounding in our *Caput mortuum*, was not a common lixivate alkali, because the *Caput mortuum*, when exposed to calcination, began early to melt in the fire, before it was near calcined, not like an alkali, but sea-salt; because the taste

was



was much nearer to that of brine, than to that of lixivium; and, lastly, because it would make no conflict with the spirit of salt, as an alkali would have done; but with a solution of silver in *Aqua fortis*, gave a white precipitate. Having dissolved, and filter'd a large quantity of this salt of urine, and suffer'd the solution to evaporate slowly, till it began to have a skin; I found the crystals it afforded, in a cool place, to be, some of them an inch or two long, and shaped almost like crystals of nitre, only they were sharper at both ends; and to many of them were fasten'd abundance of minute and oblong crystals, prettily shaped, and placed almost perpendicularly upon the greater portions of salt. These crystals, as they did not resemble common alkalies in figure, so they were unlike to them in other respects; for tho' oil of tartar *per deliquium*, being poured upon some of them, there ensued no manifest commotion, as happens when that liquor is mix'd with a salt, where an acid is predominant; yet being beaten, and mix'd with an acid spirit, as that of common salt, they made not the least ebullition, or conflict, tho' they were stirr'd up and down to excite it. Nor did *Aqua fortis* produce any hissing noise, or froth, when it was put upon the salt of urine; tho' at length it dissolved a large proportion of it. And tho' strong oil of vitriol being put upon some of the fore-mentioned crystals, did readily work upon them, and in corroding them, excited numerous bubbles; yet this did not make me conclude the salt to be alkaline; because I have observed oil of vitriol, tho' not spirit of salt, or *Aqua fortis*, to work, after the like manner, upon common salt, whereof that the fixed salt of urine partook, seems probable from the phenomenon just mention'd; because by impregnating good *Aqua fortis*, with a competent quantity of this fixed salt, instead of sea salt, I could make it corrode foliated gold, even without heat; because some part of the solution of our fixed salt, that was more slowly coagulable, being mix'd with oil of tartar, presently grew thick and muddy, and soon after let fall a large precipitate; and, lastly, because another part of the same solution did readily precipitate silver dissolved in *Aqua fortis*, but would not discolour a strong solution of sublimate made in fair water; from which a common lixivate alkali would have immediately struck down an orange colour'd powder.

A suspicion I once had, that the common salt, used to season our aliment, might, in some degree, impregnate our urine, occasioned me to examine that of horses; which I found to require rather a shorter putrefaction than human urine, to fit it for distillation. By the spirit and volatile salt of this fluid, which are easily obtain'd, it seem'd probable, that the fixed salt would have been not unlike that of human urine; tho' I had not an opportunity to examine the *Caput mortuum*. I here chose to instance in urine, because chymists never extract the fixed salt thereof; tho' all the parts of that fluid seem applicable to very good purposes.

## S E C T. II.

Different  
kinds of spirits,  
producibile.

THE chymists apply the name spirit to so many different substances, that such an ambiguous use of the word seems to shew, they have no clear and settled notion of the thing. Most of them, indeed, in the general, give the term spirit to any distill'd volatile liquor, that is not insipid, as phlegm, or inflammable as oil. But under this general idea, they comprehend liquors that are not only of a different, but, according to their principles, of a quite contrary nature; some of them being acid, as spirit of nitre, of salt, and of vinegar; and others urinous, or volatile alkalies; which are such enemies to the former, that as soon as they are put together in due proportion, they tumultuate and grow hot; and usually continue thus, till they have disarmed or mortified each other. Besides the two hostile families of spirits, there is a third, called by them vinous, or inflammable; which, tho' very subtil and piercing, is not manifestly either acid or alkaline; for the tast and smell of this species, is different from both the other sorts; and yet it is refer'd to one or the other of them, by some learned chymists; with whom I need not dispute about this matter, since 'tis sufficient for my design, if it can be made out, that all the three sorts of spirits, the vinous or inflammable, the urinous or alkaline, and the acid, may be produced.

The vinous.

And to begin with the vinous spirits. These are so producible by art, that we seldom find them produced by nature alone, which, indeed, makes the juice of grapes, but not wine, nor the spirit of it; unless, by the help of man, that juice be press'd out and fermented. And the case is yet more plain in the inflammable spirits of ale, beer, and in the like, made by boiling and fermenting the seeds, and other parts of vegetables. And 'tis observable, that must does not, in distillation, yield a vinous and inflammable spirit. I had once the pleasure to laugh at a man, otherwise very ingenious, who, to catch the subtil vinous spirit, that he would have me think was lost in the common way of treating wort, caused it to work in a copper limbec; by which means he obtained nothing but a nauseous phlegm. I have, also, found by trial, that raisins distill'd alone, afford an acid and empyreumatical, but not a vinous spirit; tho' when I carefully fermented them in a due proportion of water, they would yield, in distillation, an inflammable spirit, like that of wine.

If it be objected, that the vinous and inflammable spirit, obtained from bodies by fermentation, was actually in them before, and is only extricated by fermentation; I answer, that this is *gratis dictum*, and not to be admitted without proof; since raisins, and such other fermentable bodies, do not, upon the supposed analysis, made by distillation, afford a vinous spirit, but one very different from it. And I see not why the change.

change of texture, may not turn some part of the juice of grapes into a vinous and inflammable liquor; since a little further change is able to turn the same juice into an acid liquor, that is neither vinous nor inflammable, as it was before. And I have found by trial, that even this vinegar, crude as it is, being satiated with the calx of lead, made *per se*, would afford a spirit not acid, but of a very different taste, and inflammable, like the spirituous parts of wine. And if it should be further objected, that these inflammable spirits were not produced by such operations, but, pre-existing in the newly express'd juice of grapes, were only extricated by fermentation; and, being afterwards disguised by the acid particles of the vinegar, were again extricated by distillation; the acid salts having fix'd themselves upon the lead they corroded, and thereby given the spirits leave to forsake them; I might observe, that the objection alledges no phenomena, to make the actual pre-existence of vinous spirits appear, either in the juice of grapes, or in the solution of lead. But to examine this matter further, I made a *Saccharum Saturni* with an acid liquor, obtained without fermentation, or the addition of any fluid, from wood it self; and then distilling it, also, *per se*, I had a spirit that readily took fire, and burnt away in a blue flame, like that of spirit of wine. I know another objection may be framed from the doctrine of some chymists, who would have spirit of wine to consist of the oily parts of the juice of grapes rarified and subtilized. But I need not enter into a dispute with these learned men, since, without examining whether their opinion be true or false, if it be admitted, it will be consistent enough with mine. For to say, that by subtilization, rarification, a peculiar kind of commixture with the phlegm, or the like means, the oil contain'd in the juice of grapes becomes spirit of wine; is but to assign the *modus*, whereby vinous spirits are produced, not to deny their production. And all I require is, to have it proved, or granted, that inflammable spirits are really produced, by what way soever it be. I shall add, tho' experience shews, that honey, being skilfully fermented with a due proportion of water, will yield a greater quantity of inflammable spirit, than the wine that is made in several countries; yet when we carefully distill'd honey, as before fermentation, it afforded us a great proportion of a considerably acid spirit, that would dissolve some metals; but a surprizingly small quantity of oil: whence 'tis unlikely that so inconsiderable a proportion of that liquor, should be rarifiable into so much inflammable spirit, as may be obtained from well fermented honey.

I proceed to the other sort of spirits, as those of hartshorn, blood, sal-armoniac, foot, &c. which we formerly call'd urinous, because of their great affinity, in many qualities, to spirit of urine. But as for these, I know not whether it will be necessary to treat of their origin apart, since they seem not simple, but compound bodies, consisting of the volatile salt of the respective concretes, dissolv'd in the phlegm; and, for the most part, accompanied with some little oil, at first un-

The urinous.



*Chymistry.*  


discerned by the eye, tho' it afterwards becomes visible. The presence of this oil in most spirits belonging to this family, may, probably, be argued from the deep tincture, that, in tract of time, the spirits of hartshorn, of blood, &c. acquire by standing; tho' presently after their distillation, and first or second rectification, they were clear and colourless as water. But in spirit, drawn, by the help of an alkali, from sal-armoniac, a concrete not abounding in oily parts, like hartshorn, blood, &c. and kept for several years, I observed no such discolouration. Having, therefore, hitherto, by rectifications and digestions, found nothing in these urinous spirits but a crystalline, volatile salt, most commonly separable in a dry form, and the phlegm it was dissolved in, besides some oleaginous particles that had associated themselves to it; 'twere unnecessary to alledge particular instances as to this sort of spirituous liquors: 'tis sufficient to refer them to our considerations on the production of volatile salts.

*And the acid.*

That some acid spirits may be generated, or produced, *de novo*, must seem probable from what has been already deliver'd as to the production of acid salts; and from what we shall say of acid, urinous, and volatile spirits, obtained by distillation from the same body. And if we take the word acid, as I here usually do, in a familiar sense, without nicely distinguishing it from those sapers that are of kin thereto; perhaps the spirit of sea-salt, and that of nitre, may be proper instances of the production of acid spirits. For tho' sea-salt, and its distilled liquor, have, upon some bodies, the like operations, as either of them will precipitate silver out of *Aqua fortis*, yet the tast of the spirit of salt is exceedingly different from that of crude salt, not only in strength and penetrancy, but in being highly acid; whereas the crude salt has a tast not properly acid, but that which by a distinct name is called saline, such as predominates in brine: and it does not appear that this acid spirit pre-existed in that state, in the salt whence it was obtained; so that we may suppose it to have been made rather by transmutation than extrication. And the like, I think, may, with greater probability, be said of the spirit of nitre; for tho' this be highly acid, yet the nitre that afforded it, is not at all sensibly acid: and this new vehement tast of the spirituous parts, as well as their great efficacy in dissolving metals, and other bodies, seems to have been produced by the violent action of the fire, which, by splitting the nitrous corpuscles, or by rubbing them one against another, &c. makes a comminution of them into fragments, or particles; which, both, because of their smallness and lightness, may be elevated by the action of the fire; and because of the same minuteness, and their sharp pointed figures, may get into the pores of many other bodies, and divide their parts. Chymists, indeed, may object, that all the acid spirit, which can be distill'd from nitre, was really pre-existent, and only clogg'd and disguiz'd by the alkaline ingredient, wherewith it was associated; as may appear, by what I related, of the quick way of making salt-petre, by putting

putting a due proportion of the spirit of nitre to the alkali, or *Chymistry.* fix'd part that remains after the salt-petre has been fulminated. This proves, indeed, what I readily grant, that salt-petre may be artificially compounded of a nitrous spirit, and a fix'd alkali; but does not prove, that nature always, or ordinarily, produces nitre, by compounding it of the same ingredients: for, it does not appear, that wherever salt-petre is generated in the earth, nature has, beforehand, laid in a provision of lixivate salt, that is not, with us, to be made, without the violence of an incinerating fire, and of corrosive spirits; to obtain which, or either of them, vehement fires are employ'd; whilst salt-petre seems to be slowly generated in the earth, by gradual, or successive alterations of some proper matter; wherein, for ought I have observ'd, not an acid, but an urinous salt is predominant; since earth, that had long lain cover'd with pigeons dung, in a dove-house, yielded a volatile spirit and salt like those of urine, in distillation. I will not, therefore, affirm, that nature never employs fix'd alkalies, and acid spirits, to make salt-petre; yet, I see not that chymists have hitherto offer'd any cogent proof, that she must necessarily do so. I farther observe, that, according to what was formerly noted, salt-petre, distill'd in close vessels, affords but an inconsiderable quantity of fix'd salt; and that too, a very imperfect alkali; tho' the quantity of nitrous spirits was great enough to persuade us, that nothing near so much as was wanting of the entire weight of the salt-petre, had pass'd into the receiver. And a friend of mine, by the help of a peculiar clay, obtain'd near a pound of spirit of nitre, from a pound of salt-petre; whilst, on the other side, by a different management, tho' without addition, I obtain'd about ten ounces of fix'd nitre from a pound of salt-petre: whence, it seems probable, that the same substance, which, in crude nitre, is almost insipid, may, by an operation of the fire, be distill'd into a highly acid spirit, as well as, by another operation and way of management, be brought to the nature of a fix'd and caustic alkali. It may, also, be worth considering, whether the perfect spirit of nitre may not be depriv'd of its acid nature, and become, or, at least, materially concur, to make up a fix'd alkali. For, if sea-salt, which chymists do not pretend contains any such alkali, be thoroughly dissolv'd in a sufficient quantity of spirit of nitre, the salt, thus compounded, will yield a considerable proportion of fix'd alkali, resembling that of salt-petre; which is as likely to proceed from the nitrous, as from the marine part of the resulting salt: and if so, 'tis the more probable, that the saline corpuscles of spirit of nitre, are not primordial bodies, since they may be destroy'd, or turn'd into other salts: which is not less repugnant to the nature of a principle, than 'tis to be, *de novo*, producible from a body that was not acid before.

It may add much probability, to what was above said, concerning the producibleness of the different sorts of spirits, if it shall appear, that

*Chymistry.* that the same body, merely by different ways of ordering it, may be easily brought to afford either acid, inflammable, or volatile spirits, as the artist pleases.

*The same body may, by being differently treated, afford five kinds of spirits.*

An instance of this, we may have from some kinds of pulse, as beans, &c. which, if newly gather'd, and distill'd in a retort, afford, besides a great deal of phlegm, an acid spirit. And I had such a spirit from either pease, or beans, or both, after they had been kept till they lost their verdure. But if these seeds be, at a fit time duly fermented with common water, it will not be doubted, but that they, as well as other mealy seeds, must yield an ardent spirit: but, it will not be easily believ'd, that without adding any thing to them, and barely by keeping them in a dry place, for a certain number of months, they will yield a spirit, that by one, who did not know whence it proceeded, would be judg'd near a-kin to that of urine, or of hartshorn, and to other saline liquors, drawn from animal substances; yet, having distill'd these pulse, by themselves, and without so much as bruising them, they afforded spirits, not only far more like in scent to those I just enumerated, than they were either to acid or vinous spirits, but allied to them in more intimate qualities; since they would, as the spirit of urine and hartshorn, make a conflict with acid spirits, turn syrup of violets green, dissolve copper blue, precipitate a solution of sublimate into a white substance, and give the other distinguishing marks of volatile and urinous salts and spirits.

Vegetables, also, may easily, by a dextrous sublimation, be brought to exhibit many of their nobler parts in the form of a dry salt, as well as in that of a spirituous liquor.

The fresh juice of grapes, or must, tho' sweet in taste, will, if it be timely distill'd to the consistence almost of a syrup, yield a great quantity of phlegm, but no ardent spirit; and if the superfluous moisture be skilfully evaporated, there will remain a kind of sapa, of a pleasant tartness, which I have known used in some places, as an excellent ingredient in sauces, and also to spread upon bread, instead of butter.

But if this sapa were presently distill'd, I suppose it would yield no vinous, but an acid spirit; tho' for want of vineyards in *England*, I could not examine any liquor taken out of great vessels of must, and therefore cannot say, precisely and experimentally, what distill'd liquors it wou'd afford; since I know not, certainly, whether the large quantity of the sweet liquor, and its continuance for some time in the state of what they call must, may not somewhat alter its productions: but if, as it is probable, that diversity be not considerable, I may safely suppose the vinous spirit, afforded by the juice of grapes, after fermentation has turn'd it into wine, is a produced thing, and was not in that form pre-existent in the juice; for having purposely caused ripe grapes to be moderately press'd, that the juice might, without much

*An acid and a vinous spirit from the juice of grapes.*



much dreggy matter, be squeezed out; we put this liquor into a glass head and body, and, distilling it with a gentle fire, obtained a scarce credible proportion of phlegm; and then transferring the inspissated remainder into a retort, after having kept some of it for sapa, we prosecuted the distillations with a stronger fire, and obtained not a vinous, but an acid spirit; as we found by its smell and taste; by its corroding fragments of coral, even in the cold; by its growing sweet upon minium, &c. Agreeable to this experiment I found, by trial, that raisins, which consist chiefly of the juice of grapes inspissated in their skins, by the avolation of the superfluous moisture thro' their pores, being distill'd in a retort, did not afford any vinous, but rather an acetous spirit, that as an acid liquor wou'd work upon several bodies like spirit of vinegar; and yet, as was formerly noted, 'tis known that raisins, being fermented with a due proportion of common water, will, after a certain time, afford a vinous and inebriating liquor. And tho' in the better sort of the known ways of making artificial wines, many months, are usually spent in the preparation; yet I have practised a method which consists chiefly in a determinate proportion of the water to the raisins, by the help of which, the liquor, in very few weeks, became fit to drink; and consequently to afford, by distillation, a vinous spirit.

Nay, from the juice of grapes, even after it has been duly fermented, there may be obtain'd by distillation, a liquor, which, having not found mention'd in authors, I take the liberty to name, upon account of its taste, and some other qualities, acid spirit of wine. And I chose to make the experiment with canary, as a wine fully ripe, and remote from an acid and tartarous nature. We took, then, some good canary, and having with digestive-furnace, and in a glass head and body, slowly drawn off the ardent spirit first, and then the phlegm, till there remain'd a liquor of the consistence of a thin syrup, we remov'd it into a retort, and distill'd it by degrees of fire; whereby we obtained, besides a sourish phlegm, that came first over, a true acid spirit; as appeared, not only by the taste, but by the hissing noise and numerous bubbles that were produced, when we poured it upon a lixiviate salt; as also by this, that having put it upon powdered corals, it began briskly to dissolve them, even in the cold: we likewise made it corrode some metalline and mineral bodies. As this acid spirit of wine has a different origin from that of other known acid spirits; and even from spirit of vinegar, I thought it probable, that it might have some peculiar qualities; and having put some of it upon filings of copper, in such manner, that part of them being first moistened therewith, shou'd remain expos'd to the air; and others lie beneath the liquor; I found, tho' the trials were made in the cold, that, in a day or two, the exposed filings had gained a fine bluish green colour; but the spirit that swam upon the other, in few hours, acquired a fine redness, which afterwards, in two or three days, degenerated into a

*Chymistry.*

*An acid spirit of wine.*

*Chymistry.*

colour like that of the exposed filings. The *Caput mortuum* of the distill'd wine I found a more fix'd body than one wou'd have expected: and tho' probably the finer part belonging to the juice of grapes, being attenuated and subtiliz'd, was changed into an ardent spirit, and therefore appeared not in the distillation in the form of oil; yet 'tis not unlikely, that the courser part of the oleaginous substance remained still in the *Caput mortuum*; for holding it in the flame of a candle, I observ'd, that it wou'd partly exhale in thick smoke, partly melt, and as it were fry, and partly burn with an actual flame, which was not only continued while that of the candle cherish'd it, but wou'd, after it was removed from thence, continue to flame for a considerable time: and a parcel of it being cast upon quick coals, burned with a blaze, almost as if it had been amber or bitumen.

*A volatile  
or urinous spi-  
rit from the  
juice of grapes.*

To return to our juice of grapes; we see, merely, by a slight difference, in point of management, it may be made to afford either a vinous or acid spirit: and I shall now add, that it may be brought to yield a volatile or urinous one; for 'tis known, that, in process of time, wine affords tartar; and tho' chymists suppose the spirit of tartar to be of a quite different nature from that of urine and of foot; and tho' tartar distill'd in the common way, affords an acid spirit, and another that I call anonymous; yet, by a peculiar and slow way of operating, I have been able to obtain from crude tartar, without any addition, a spirituous substance, that in taste, smell, and several manifest operations, much more resembled the volatile spirit of foot, obtain'd as mine of tartar was, by mere distillation, than an acid spirit; with which it was disposed to make a conflict as soon as they were put together. But such a kind of volatile substance may be, far more easily, obtain'd from the lees of wine, than from tartar; for having been informed, that an expert chymist, in *Germany*, had found the way to get much volatile salt from lees of wine, I resolv'd to try whether it might not be done without any addition; and having procured some of the best lees of *Rhenish* wine, I caus'd them to be exposed in broad vessels to the sun, and the free air, that they might leisurely dry, if not also be impregnated, in order to the volatility of their saline parts. Then these dry'd feces being carefully distill'd in a retort, by degrees of fire, the liquor was slowly rectified; by which means there ascended, before the phlegm, a spirituous part, which wou'd turn syrup of violets green, precipitate dissolv'd sublimate into a white powder, soon colour it self upon copper with a deep blue, &c. from whence we may infer, that the same matter, as it is differently managed, may be made to afford an acid, and one we call anonymous, an acetous, a vinous, and a volatile spirit.

*Observations  
upon a new a-  
nonymous spi-  
rit.*

And here I will relate some of the more expeditious and easy trials that I have made about that kind of liquors, which I styl'd anonymous; because when I first separated them from the acid spirits, wherewith chymists had before confounded them, their properties were

ve-

very little known to me; but having since found them to differ in several qualities from vinous, from acid, and from urinous spirits; and having not sufficiently discover'd their positive properties, I call each the neutral, or adiaphorous spirit of the body that affords it.\*

But 'tis here proper to premise a few things in the general. 1. Our adiaphorous spirit may be obtained, by distilling the liquor afforded by woods, and several other bodies, from coral, or calcined lead; for by this means the acid corpuscles of the menstruum will work upon the coral, or the lead, and so fasten themselves to what they corrode, as easily to part with the adiaphorous spirits, which are thus permitted to ascend, by themselves, and fall into the receiver in the form of a liquor. I endeavoured to try, whether there was any difference in gravity or fixedness, between the acid and neutral spirit of wood, without mortifying the former; and whether, by the help of this gravity and fixedness, I could separate the acid from the other, and so preserve it distinct.

In order to this, I caused a quantity of the rectified spirit of box, to be slowly distill'd in a glass body and head, placed in sand, with the flame of a lamp; and in the first 24 hours, obtain'd but about two spoonfuls of liquor; and tho' the menstruum first put in, scarce exceeded a pound, yet it was several days and nights in drawing over. And in the operation, the liquor that first ascended was not phlegm, but had a very piercing tast; yet without any manifest acidity discoverable

\* 'Tis observed by M. Homberg, that towards the conclusion of the analysis of a plant, unfermented, there usually comes over a certain liquor, which appears to be both an alkali, and an acid; for it makes a strong ebullition with spirit of salt, and changes the tincture of turnsol red. To examine into this phenomenon, he separately distilled two plants, the one abounding in volatile salt, the other in acid; and rectifying the acid of the one, till it resembled distilled vinegar; and purifying the salt of the other, he plentifully dissolved of this salt in its urinous spirit. Then mixing the two together, no ebullition ensued; tho' they would both, apart, make a very great effervescence, the one with spirit of salt, and the other with oil of tartar: and long continuing thus quietly together, he had a desire to separate them by distillation; but a very gentle heat first raised a liquor lightly urinous, and at length there ascended a white, crystalline, saline salt, that yielded something of an urinous scent. This increased his wonder; for such a volatile salt from plants he thought a new thing in chy-

mistry. This ingenious gentleman, afterwards poured about six parts of distilled vinegar, upon one of spirit of urine, well saturated with salt, and no effervescence, nor ebullition ensued: and these were distill'd in the same manner, with the same effect as the former. Hence M. Homberg concludes, that there is a certain proportion of force required to make an acid work upon an alkali. For, in these cases, the acid is on one side too weak, and the alkali too strong. A vegetable acid, he says, is a *Sal terra*, attracted by the plant, ground, broke to pieces, and weaken'd in the circulations and fermentations it undergoes therein; but, that a strong spirit of urine, well impregnated with volatile salt, must be full of solid, massy parts, which lying close by one another, are not to be separated by a small force. And, accordingly, a mineral acid, which has never been weaken'd like the other, eagerly falls upon that spirit of urine, and so will the vegetable acid too, if the urinous spirit be sufficiently diluted and weaken'd with phlegm. See *Memoir. de l'Acad. A. 1701. p. 283.*



*Chymistry.*

by the tongue, tho' by putting it upon fine powder of coral, it had some operation, that made me think it not wholly void of acid particles. And having often shifted the receiver, the better to judge whether the portions of the ascending spirit were considerably different in quantity, I found the liquor that came over towards the latter end, sharper than before: and having, at length, distilled all I could make rise, we found the last parcel to be of a good yellow colour, tho' those that preceded it were limpid; and this was in scent strong of vinegar, and to tast more acid than spirit of common vinegar; so that had I not known how it was obtained, I should have suspected it to be *Acetum radicum*; and, accordingly, I found it to be a very active menstruum in the dissolution of some bodies, that, for trial sake, were put into it. Now all this seems to argue, that the acid portion of such distilled liquors, is more ponderous, or more fixed, than the adiphorous spirit, which, upon that account, may be, in great part, separated from it by bare distillation, if carefully performed.

2. I have observed these neutral spirits to be not, all of them, in every respect, of the same nature; for tho' they agree in some general properties, which entitle them to the same species or denomination, yet they sometimes differ from one another in particular qualities. It must not, therefore, be thought strange, if some of the experiments I shall set down, do not punctually succeed in their hands, who shall not make use of the anonymous spirit of box, which I employed; for when I speak of an adiphorous spirit in general, I mean the spirit of box; which I had freed from its acid part, by distilling it from calcined coral.

3. Tho' the few chymists, who have taken notice of the distilled liquors of woods, for example, look upon them, by reason of their acid taste, as merely acetous, and accordingly call them the vinegars, or acetous spirits of wood; yet, really, the acid portion of these distilled liquors, is far from being the greatest. For, besides what other trials I have made to shew this, I took eight ounces of the rectified spirit of box, wherein the acetous and neutral spirit remained confounded, as they had been in the first distillation; and having poured this upon a quantity of calcined coral, sufficient to satiate the acid corpuscles, which quickly fell to corrode it with noise and bubbles, we gently distill'd it, to a dryness, in a glass head and body; by which means we obtained of adiphorous spirit very near seven ounces and a half: and some of the menstruum being wasted in the operation, the acid corpuscles remaining in the bottom with the coral they had corroded, weighed but between two and three drams; which shews, that notwithstanding the considerable quantity of strong spirit of vinegar, that the distill'd liquor of box contains, the corpuscles that make it so acid being concentr'd, take up but little space. And as it was rational to suspect, that the acetous corpuscles, being made without fermentation, might have something peculiar in their nature, I caus'd them

them to be gradually distill'd, with a strong fire, from the coral; and thereby obtain'd a very red spirit, which, tho' many chymists wou'd take it for a volatile tincture of coral, was of a very strong scent, and a tast exceeding piercing, but very different from that of acid liquors. *Chymistry.*

Whether our adiaphorous spirit may be generated by the commixture of the finer parts of the oil of the wood, reduc'd to an extraordinary minuteness, and thereby render'd fit to be exquisitely mix'd with the phlegm, and strictly associated with its particles, I shall not, till I am better furnished with experiments, venture to determine.

Having premis'd these general observations, I shall proceed to particulars; but desire it may first be noted, that for the better discerning the phenomena to be produced, I made almost all the following experiments in cylindrical glasses, about an inch in diameter.

(1.) Having into our adiaphorous spirit of box, drop'd a convenient quantity of strong transparent oil of vitriol, and shaken the liquors together, there presently emerg'd a rich and lovely red colour, which, at first, was diaphanous, but afterwards grew so deep as to be opaque; tho' by shaking the glass, the thin liquor that wou'd slowly glide down the inside of it, being held against the light, manifested the colour to be still red, but much more dark than before.

(2.) Some common *Aqua fortis* being put to our neutral spirit, and shaken a little with it, presently gave it a rich amber colour, but not a true red; but if the liquors were not mingled by agitation, the spirit slowly and gradually obtained the same colour: after this change, the spirit continued transparent; and, which ought not to be omitted, the change, at first, was wrought without any manifest precipitation, tho' afterwards, when the mixture had rested a good while, there appeared some little and light feculency at the bottom of the glass; and the inside of it, as far as the liquor reach'd, was sullied with a cloudiness not easy to be washed off. One circumstance more of this tryal too, I must not omit; that notwithstanding the strong and offensive smell, usual in *Aqua fortis*; it had in our mixture either none, or a very faint one; being conceal'd, suppress'd, or disguised by the predominant odour of the adiaphorous spirit.

(3.) Some spirit of salt being added to our spirit of box, the mixture became much less transparent than the liquors before their conjunction, and for a day or two, was only whitish; but when we remov'd it into a digestive furnace, and kept it there for many hours, it acquir'd a high colour, partaking of brown and yellow; and appeared to have let fall some little sediment.

(4.) Having put some of our adiaphorous liquor on salt of tartar, it had not any sensible operation upon it, except that it dissolv'd the salt, and, after some digestion, appeared of a yellow colour, tending to brown, and fasten'd to the inside of the vial in many little grains of

*Chymistry.* salt, that seemed to have been first dissolv'd, and then coagulated again in new figures.

(5.) Our adiaaphorous liquor being confounded with highly rectified spirit of wine, neither of them appeared, considerably, to change their colour; there only appeared a small tendency to a yellow, or to grow opake by their conjunction, even after some days digesting; but the vinous spirit did not hinder the other from turning red, by the action of some strong acid, when poured on the mixture.

(6.) Rectified spirit of urine, put to our adiaaphorous liquor, did not make any conflict, but joined quietly, with it, or manifestly change the colour of either, whilst they were kept many hours in the cold; but being transferr'd into a digestive furnace, and there detain'd for a night or two, the liquor acquir'd a high colour, which was almost orange-brown; and there appeared some little feces at the bottom. Having made these tryals upon our spirit with simple liquors, I thought fit to make some with such compounded ones, as the solution of metals; to see, tho' it were neither, manifestly, of an acid, an urinous, or a lixivate nature, if it wou'd precipitate any part of the dissolved metals.

(7.) To prosecute this inquiry, I drop'd into some of our spirit, a little solution of refined gold, which, at first, imparted its own colour thereto; but the mixture quickly lost its transparency, and grew muddy, and, after a while, let fall a considerable quantity of sediment, or precipitate; the upper liquor having acquired a brownish colour.

(8.) Having mix'd our spirit with a good solution of crude lead, made with an appropriated menstruum, that dissolves it readily, and clear, almost as *Aqua fortis* does common silver; the mixture presently became muddy, and after some days let fall a large sediment, over which swam a liquor between brown and red.

(9.) We put to our spirit of box, some fine blue solution of copper, made with an urinous spirit; and soon perceiv'd the mixture to grow turbid, which afforded us, tho' but very slowly, a plentiful residence.

(10.) We mixed with the same spirit a convenient quantity of strong infusion of sublimate, made in fair water; but found not any manifest action between those liquors, no more than between dry and undissolved sublimate, and the same spirit, when we kept them together, in this same vial.

(11.) Mixing our spirit with oil of tartar *per deliquium*, there did not, suddenly, appear any manifest change; but having digested the mixture for several days, there precipitated a light feculency, whilst the upper liquor, which was transparent, appear'd of a colour inclinable to red.

(12.) We, also, mingled with some of it a convenient quantity of vitriol of copper, dissolv'd in fair water, till the liquor seem'd satiated.



ted with the vitriol; but I remember not that, in several days, the solution grew manifestly opake or discolour'd. *Chymistry.*

(13.) We put to our spirit a solution of tin, made in a menstruum that dissolves it clear; but very little alteration ensued, tho' we left the liquors for many hours together.

(14.) But, when I put to our spirit a convenient quantity of the solution of mercury, made in *Aqua fortis*, the colour of the mixture became first deeply yellow; and, in a minute or two, intensely red; and being digested for some days, I found, at the bottom of the vial, a white precipitate, much larger than I expected; and the transparent liquor that swam above it, was of a rich golden colour. Whether physicians or surgeons shou'd apply this precipitate, or tinged liquor, to medicinal purposes, I shall leave them to consider.

(15.) Several of the foregoing experiments were try'd with the spirits of other woods; besides box, and in particular, with those of oak and guaiacum; the phenomena whereof were not, always, the same with those above recited; which may, probably, argue some difference in the nature of such spirits, as there is in the constitution of the woods that afforded them.

(16.) Having put of our neutral spirit upon some pieces of fine red coral, and kept them together for many days, the liquor did not appear to have extracted any tincture from them; tho' the upper part of the highest fragments seem'd to be turned white.

(17.) And, lastly, taking a parcel of this spirit, that came over by rectification, in a lamp-furnace, long before the more fixed acetous spirit ascended, I exposed a vial, scarce half full of it, in a very sharp frosty night, in a garden covered with snow and ice; but it was taken up, the next morning, not at all frozen, tho' less limpid than before; and thus it continued, either in a greater or less degree, for some weeks after.

### S E C T. III.

THE substances which chymists call the sulphurs of the mixed bodies, that, by the help of the fire afford them, are not of so uniform a nature as might be expected in the portions of the same principle. For, as on the one hand, they make inflammability the constituent character of sulphur; so on the other, 'tis obvious, that there are, at least, three substances, manifestly different in consistence, texture, or both, which, according to that notion, ought to be referr'd to sulphur. For sometimes the inflammable substance, obtained from a mixed body, by means of fire, appears in the form of an oil, that will not mix with water; sometimes in the form

*That sulphurs are producible.*

Chymistry.

form of an inflammable spirit, which will readily unite with that liquor; and sometimes, also, in the form of a consistent body, almost like common sulphur.

'Tis not, however, impossible, that in most mix'd bodies, what is called sulphur, may be no primordial ingredient, but rather a generated or resulting thing. For what is common to these different bodies, which pass under the name of sulphurs, and is the essential quality that discriminates them from the other material principles of mixed bodies, must be confess'd, if we will speak intelligibly, to be a disposition to be turn'd into fire, and usually, also, into flame. But sulphur, it self, is made of the same universal matter whereof other bodies consist, and is only a coalition of certain particles thereof; whose aggregate, by having a particular texture, motion, &c. acquires those properties, on whose account it is called sulphur. And, therefore, if the like texture be found in other portions of matter; or if art and chance can frame, and bring together particles of matter, and give them such a texture, as disposes them to be kindled, and flame, or burn away; these qualifications of such an aggregate of corpuscles, entitle it to the nature of a sulphur; whether this portion of matter consist, or largely participate of the chymists primeval sulphur or no. For, it is not by virtue of the long duration of a thing, but by the essential qualities belonging to it, that a body deserves its denomination. Thus, the snow that fell yesterday, and was generated instantly, is as true snow, as that which has lain for many years on the *Alps*. And, in the judgment of the chymists themselves, a pound of quick-silver newly transmuted, by a grain or two of their elixir, into gold, becomes as true gold as that which was coeval with the most ancient mines of that metal.

Shewn in oils.

That 'tis not necessary the oil or sulphur, obtained, by the fire, from mixed bodies, should be a primeval element, or principle, may be probably argued from the growth of plants, fed merely by water; which nevertheless afford an oil in distillation. And, we see, that in almond trees, walnut trees, &c. the rain water, which insinuates it self into their roots, is, by successive changes of texture, reduced into the oil, which the fruit, by expression, so plentifully affords. And, to obviate the suspicion, of common waters being impregnated with the grosser juices of the earth, I employ'd distill'd water to nourish a plant.

A sprig of mint, put into rain water distill'd, and fed, almost wholly, with re-distilled rain water, weighed, at first, three grains; and being taken out when it had grown less than a month, weigh'd, after it was well dry'd with paper and a cloth, ten grains and about a quarter. Another sprig, put in and taken out at the same time with the former, had attain'd to near four times its first weight; and shot out a second sprig much higher than the first, and many roots, some of them near as long again as the whole plant when it was first put in.

If

If we consider what a great quantity of oil is afforded by an olive yard, *Chymistry.* whose trees are, probably, nourished chiefly by rain water, that, being imbibed by the roots, is by various digestions, or preparatory changes, turned into oil; it will appear probable, that oil may be produced of other substances; since in our instance it seems to have been made by a transmutation of water; tho' this be generally reputed of all liquors the most contrary to, and is evidently of a nature exceeding distant from it.

And here I will relate an experiment, by which I attempted to produce oil out of only two distilled liquors, that, according to the common estimation of chymists, are uncompound bodies; however, they are each of them readily dissoluble in water, and in one another. Take, then, of oil of vitriol, and of such spirit of wine as is totally inflammable, an equal weight; mix them together, by degrees, lest the heat they will produce, should cause some inconvenience; and having digested them, with a very wary management of the fire, draw off what will come over; and you shall obtain, besides a subtile and odoriferous spirit of wine, and an acid, sulphureous liquor, a considerable quantity of chymical oil; which I have had sometimes deeply coloured, and sometimes clear like fair water. Nay, it has sometimes been exceeding fragrant, and without any acidity at all; tho' the taste of it was very subtile and piercing, but no way like that of any saline liquor I know: whence we may doubt, whether it is made of the spirit of wine, or of the oil of vitriol. The circumstances last mentioned seem to persuade the former; especially since I found, by trial, purposely made, that this oil would readily mix with good spirit of wine, which had never been concern'd with oil of vitriol: but, on the other side, it seemed considerable, that the oil of vitriol, by this operation, was much weaken'd and changed; and it appeared not whence the spirit of wine should have so great a fragrancy. Besides, this oil was so ponderous, as to sink not only in common water, but in the acid spirit it self; which seemed to be the remains of the alter'd oil of vitriol. But I need not be solicitous to determine, which of the two liquors afforded this strange oil; for it may well be composed of both, by their mutual action, and the operation of the fire. If it be said, that this inflammable substance is made by the extrication of the parts which lay concealed in the liquors, before they were brought together; it may be answer'd, that till this be prov'd, our cause is favoured by the experiment, wherein there appears nothing so likely as a change of texture, to produce our anomalous, chymical oil; since it plainly seems to result from two bodies, whereof neither was a true oil before. For each of them would readily mix with water; whereas this oil of ours being shaken with water, would break, like common oil, into numerous little globules, which, presently after, sunk to the bottom, and re-united there into a liquor, that I have kept, for several weeks, in the water, and found it, at last, undissolved thereby.

Some



*Chymistry.* Some odd properties of this oil make it seem likely to participate of the nobler parts of vitriol; and the sulphur of that having extraordinary virtues ascribed to it, by some of the most famous and intelligent chymists, I kept a quantity of this oil, for several years, to observe the alterations that time would produce in it; and afterwards I imparted the medicine; the first trial whereof prov'd very successful.

And tho' chymists should prove, that our oil was but separated from the spirit of wine, or the oil of vitriol, in which it was latent before; the experiment would still afford a considerable reason for questioning a principal point in the vulgar chymical doctrine; wherein 'tis confidently pretended, that, from the number of supposed similar substances afforded by a mix'd body, it was actually compounded of a set number of distinct and true material principles, and a determinate quantity of each. For if from a distilled liquor, as the oil of vitriol, or from alcohol of wine, which is commonly reputed un-compounded, a liquor of quite another kind may be separated; how little reason have we to take it for granted, that every distilled liquor, supposed one of the component principles of the body that afforded it, is a homogeneous substance, not further divisible into different parts?

*And in consistent sulphurs.*

As for the production of that kind of sulphur, which goes under the name of inflammable spirits, it is sufficiently considered in treating of vinous spirits. But what I have hitherto said, indeed, relates only to inflammable liquors; whilst it may be pretended, that sulphur, in its proper and primary acceptation, signifies a mineral body. But, as we formerly said, the chymists use the term sulphur so ambiguously, that 'tis hard to avoid the confusion which they seem to have affected; yet, because the most intelligible and particular notion their writings suggest of sulphur is, that 'tis a combustible and inflammable principle, I have hitherto treated of it as such. And as for that substance which is commonly known by the name of sulphur, tho' there are chymists, who have affirmed they can separate such a sulphur from vegetables and animals; yet since they teach us not the way of doing it, nor give us any proofs, besides their own words, that they have done it themselves, the thing has seemed improbable to the more judicious of their own party; only a follower of *Glauber* I find to have undertaken, by his master's directions, to produce a real sulphur, like the mineral, out of vegetable charcoal, by a way, which, because it has deceived more than him, and is specious enough to impose upon the less cautious, I shall here set down and examine, as I made it after the author.

We took equal quantities of good oil of vitriol, and of common sea-salt, dissolved in as much water as was requisite; this mixture we slowly distilled, till the bottom was thoroughly dry; then setting aside the liquor, we took out the *Caput mortuum*, and having beat it to powder, with  $\frac{1}{4}$  or  $\frac{1}{5}$  part of its weight of charcoal, we put it in a strong crucible, and kept the mixture melted in a vehement fire, till it  
grew

grew of a dark, reddish colour: by this time such a change was made in the mass, that it both smelt and tasted rank of sulphur; and if spirit of sal-armoniac were seasonably distill'd from it, with a moderate fire, the ascending spirit would be manifestly impregnated with sulphur, that was easily separable; which may also be by several other ways obtained from the same fixed *Caput mortuum*.

I do not, however, take the sulphur thus produced, to have been the vegetable sulphur of charcoal, but a mineral one, that lay conceal'd, in a liquid form, among the saline parts of the oil of vitriol.

For 'tis not likely, that so small a quantity of charcoal as was employ'd in this experiment; and much less, that so small a quantity as may suffice to make it, can contain so much sulphur, as might this way be obtained.

And that common vitriol is not destitute of mineral sulphur, appears from the sulphureousness of the marcasites whereof 'tis usually made. So that in several countries, as about *Liege*, and in some parts of *Italy*, from the same substance that affords vitriol, they obtain, by distillation, great quantities of common sulphur, which is sold for such to other countries. And I have found, that there may be obtained from vitriol, an oil, and a *Caput mortuum*, which, put together, afford an intolerable scent of common sulphur.

And I have, several times, purposely try'd, that by distilling together common oil of turpentine, and common oil of vitriol, the former of those liquors would make a separation of some of the sulphur, that lay concealed in the latter, and as it were extract it; so that, besides an exceedingly sulphureous liquor, which was sometimes made white by the dissolved sulphur that pass'd into the receiver, we had in the neck of the retort, a yellowish, solid body; which being put upon quick-coals, would, after a little yellow flame, afford much bluish flame, like that of common sulphur, which it also resembled in smell. And such a kind of sulphur I have also seen, in tract of time, settle it self, in considerable quantities, at the bottom of the liquor distilled from the mixture of the two oils above mentioned. Nor are these the only ways by which I have obtained from oil of vitriol manifest proofs of its containing a mineral sulphur, very like the common sort.

And, in particular, I once put into a retort, one part of running mercury, and four of oil of vitriol; and having distill'd off the menstruum by degrees of fire, there remained at the bottom of the glass a very white powder; which being afterwards gradually urged with a stronger fire, afforded, in the upper part of the retort, a great many small bodies, that looked like half beads of amber. These, by their aptness to melt, by their smell, and by the bluish flame they afforded when burnt, appeared to be a kind of sulphur; which seems far more unlikely to have proceeded from so homogeneous a body as quick-silver, than from the oil of vitriol; wherein we have shewn

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there are many sulphureous as well as acid corpuscles. And as upon uniting the oils of turpentine and of vitriol in a due proportion, I constantly observed, that they incorporated into a mixture that was deeply red; I suspected the chymical cause of this phenomenon might be, that the oil of turpentine made a solution of several sulphureous particles it met with in the oil of vitriol; as we see that common flowers of sulphur give a redness to the oil of turpentine, when dissolv'd therein. And accordingly I found, that several other chymical oils, and even oil of aniseeds, wou'd presently acquire the same colour, when carefully incorporated with a due quantity of oil of vitriol.

As to the sulphurs of metals and minerals, I confess I have not yet found enough, either in chymical writings, or my own experience, to let me speak positively about them. It may be doubted, whether the sulphurs that are sometimes obtainable from minerals, belong'd to those minerals, as essential ingredients; or were only corpuscles of common sulphur, perhaps a little alter'd, and mingled in the bowels of the earth, with other parts essential to the mineral. Thus we see in native cinnabar, the mercury which chymists suppose a compleat metal of it self, is so mix'd with another body, as not to be, distinctly, discernable till separated by the fire. And from this cinnabar I have, sometimes, by an easy way, obtain'd a sulphur. Since also, as we lately noted, the vitriolate marcasites afford much common sulphur by a gross method of separation, it shou'd seem probable, that some common sulphur may remain more closely mix'd with the saline and metalline parts of the vitriol, afforded by the same marcasites; from which latent corpuscles of sulphur may, in part, proceed the sulphureous smell, &c. observ'd in vitriol and its oil. And, perhaps, the same consideration may account for the sulphureous qualities sometimes found in the liquors that pass for the vinegars of mineral bodies; and particularly antimony; to which may, now and then, be added some metalline ores; for I have had such a sulphureous liquor from good lead-ore, dug out of the mine at *Mine-deep*. And that nature her self may blend an imperfect mineral with lead, I have observed in an ore of a mine so different from the other ores of the same country, that I did but diffidently guess 'twas a natural mixture of lead and antimony, till particular tryals had justified my suspicions.

But tho' chymists pretend to teach us ways of extracting the true sulphurs of minerals and metals; and tho' I know, from experience, that a real combustible sulphur may be, in a considerable quantity, obtained from antimony; yet chymists often deceive themselves and others, by mistaking those things for the true sulphurs of minerals and metals, that really are not so. Of this I shall give a plain instance, in the preparation that many of them deliver of the sulphur of antimony. For when they have boiled that mineral in a strong lixivium

of



of pot-ashes, they suppose, that, as by the same operation common sulphur is dissolv'd, so the menstruum seeks out, and takes up, only the sulphureous parts of the antimony: and as common sulphur is precipitated out of the lixivium, wherein 'tis dissolv'd, by adding vinegar, or some other acid to it; so they presume, that what is struck down by the same way, from the solution of antimony, made in the same menstruum, must be the true sulphur of that mineral; and in this they are confirmed by the colour. And yet, in reality, not only the sulphur, supposing there is one, but the other parts of the antimony, will be dissolv'd by a strong lixivium; and the yellow powder that is precipitated, is but a kind of crocus, which will sometimes subside of it self, without the help of an acid. Nor does it shew, that such a body, obtain'd from a mineral or metal, is its true sulphur, because it may be made to burn; for unless the colour and smell of the flame concur, I shou'd suspect, that the inflammability may be apt to arise from the great comminution of the prepared body, and from the addition employed in preparing it. For these two may so greatly contribute to the inflammable disposition of a body, that little or no sulphur will be necessary to make it burn. Thus when an equal weight of sublimate has been distill'd from plates of copper, the remaining mass will melt and burn at the flame of a candle, almost as readily as sealing-wax. And it may be made appear, that combustible and inflammable bodies consist of parts which, singly, had no such quality; yet the contrary of this is supposed in the argument, that from such qualities infers the presence of sulphur in all those mineral preparations wherein they are found. I wou'd not, however, be thought to derogate from the medical virtues of such supposed sulphurs; for they may be very useful concretes, tho' not true principles; the finer parts of the mineral being in some of these preparations extracted and further divided, and, perhaps, very luckily associated with the finer parts of the body employed to act on them: by which means there may result new substances of great virtue and use. And to obtain these magisteries from metals, I employed no acid menstruum or liquor made of a particular salt; but a neutral or compounded salt; which, whilst it was in actual fusion, wou'd dissolve or corrode the metal that was reduced to thin plates. But there is another sort of bodies obtain'd from some minerals, and perhaps from metals too, that has a greater resemblance to mineral sulphur than these crocus's.

By putting *Aqua fortis*, in a certain proportion, upon crude antimony, and, after it was almost totally distill'd off, increasing the fire till a dry substance began to sublime, we had, in the upper part of the retort, a yellow brittle substance, which being carefully separated from the dark-colour'd antimonial powder, that was also elevated by the force of the fire, appeared not only by its own colour, but that of its flame, and some other signs, to be much of the nature of com-

*Chymistry.*

mon sulphur: and this is not the only way whereby we have obtain'd such a substance from crude antimony, which has yielded us a yellow and combustible sulphur, even without the help of a menstruum. *Paracelsus*, indeed, pretends to a way of drawing sulphurs from all metals; but because I am not able to reduce it to practice, nor clearly to understand his meaning, and the true nature of the instruments he wou'd have employ'd, I will not take upon me to determine, whether the sulphurs he teaches to be obtainable, by this method, be genuine, and fit to decide the present question.

However, we have sometimes by cementing very thin plates of a certain metal with burn'd alum, and afterwards dexterously elevating the more dispos'd parts with sal-armoniac, obtain'd a sublimate, from whence we separated, by ablution with fair water, that dissolved the salt, a substance, which, by its inflammability, appeared a kind of metalline sulphur.

But, probably, even this sort of bodies, drawn from a metal, and from antimony, may not be the effects of a bare separation of pre-existent sulphur, from the other ingredients of the substances that yielded them; but new concretes, produc'd by the operation of the fire on those bodies, and by the combination of some of their parts with those of the addition, employed to obtain the sulphurs. For, as far as I have yet seen, either salt-petre, crude or distill'd, menstrua made of it, other kinds of salts, or oleaginous liquors, are employ'd on these occasions. And 'tis very possible, that some of the more disposed parts of them may associate with those of the mineral or metal, to be wrought upon; and so from this combination of the ingredients, there may result a body of a new texture, which texture may dispose it to be combustible or inflammable, whether the ingredients, in their separate condition, were so or not. Thus tho' *Aqua fortis* be not inflammable, nor a piece of crude copper inflammable or combustible in a common moderate fire; yet the metal being dissolv'd in *Aqua fortis*, and the superfluous moisture warily exhaled, there will remain a fusible concrete, wherein the copper, being much comminuted, and its small parts fitly associated with the saline ones of the menstruum, composes a kind of vitriol, that, being held in the flame of a candle, or even of a piece of paper, will readily burn away in a finely colour'd flame, which may be kept distinct from the other.

In short, it seems not improbable, that, if any of the metals be, by a fit menstruum, or proper ingredient, reduc'd to parts minute enough, and these parts be fitly associated with some of those of the menstruum, the metal may, thereby, be brought to burn or flame; as I have successfully tryed upon gold it self, whose sulphur the chymists wou'd have us look upon as incombustible; so that for ought yet appears, 'tis allowable to suspect, that the sulphur obtain'd from a particular metal, is not so much an elementary or hypostatical principle, barely

barely extracted, as a magistery, or some other new compound, made by the combination of the metalline particles, with the body that works on them. But if a chymist will have metalline preparations of this kind, to be sulphurs, I may be allowed to make them serve for instances of the producibleness of sulphurs.

S E C T. IV.

**C**HYMISTS have given us no settled notion of their mercury, but have left us to guess what they mean by it. That which seems agreed on by most of them, when they speak a little intelligibly of the principle mercury, is, that 'tis a fluid substance, or volatile liquor, which therefore may be distinguished from the saline principle, especially from the alkaline, or fixed salt; as it may also be from the oil or sulphur, by its not being inflammable. But these marks will not discriminate it from phlegm, which is also a fugitive and uninflammable liquor; and therefore to make the difference, they must add some other quality, such as taste, which is wanting in phlegm. So that, according to this doctrine, the nature of a chymical mercury, or spirit, will consist in its being a volatile liquor, not inflammable, like oil or sulphur, nor yet insipid like phlegm. But what a principle must this be, that comprizes such different bodies, as acid spirits, as those of nitre and vitriol; the urinous, as for instance, those of blood, hartshorn, &c. and the anonymous, as those of guaiacum, honey, &c. freed from their acidity; and the running mercuries of minerals and metals, as cinnabar, antimony, and lead? But as for the mercuries, or uninflammable spirits of vegetables, and animals, I have endeavour'd to shew their production, in treating of spirits and volatile salts. And, therefore, I need only now speak to the production of mercury, more properly so called, that is, running mercury.

*Mercuries producible.*

That there may be extracted, or obtained from metals and minerals, a fluid substance, in the form of running mercury, is the common opinion of chymists; and in their writings we may meet with many processes to make these mercuries.

*Whether running mercuries are obtainable from metals and minerals.*

But several of the more learned chymists themselves, have look'd upon the pretensions of others to the art of making them, as a chimaera; and some judicious modern writers have exploded all these mercuries of bodies as meer non-entities; nay, some do not scruple to censure all those who pretend to have seen, or made any of them, as credulous, or impostors.

I here propose to examine, whether from a metal, or mineral, there may, without the addition of any substance, that certainly contains common quick-silver, be obtained, by art, a substance resembling that drug.



*Chymistry.* drug in weight and fluidity, in amalgamating with gold, and some other metals, and in being indisposed to wet or stick to bodies, that are not of a metalline nature.

Now there are several processes of making the mercuries of bodies, so darkly deliver'd, that the generality of chymists cannot understand them, so as to put them in practice.

For some of these processes are set down in terms of art, which, for their great darkness or ambiguity, are utterly unintelligible, but by the authors themselves, or those who are vers'd in the more mysterious parts of hermetic philosophy. And others there are of these processes, that require some menstruum, salts, or other instruments, not in the power of ordinary chymists to procure.

Instances of this kind frequently occur in the writings of such as pass for the adept philosophers; for instance, in *Lully's* method of making mercury of silver; *Helmont's* way of preparing mercury of lead; and *Paracelsus's* way of extracting the mercuries of all metals.

Again; there are several processes to make mercuries of bodies, either false, or attended with such circumstances, as render them unfit to be trusted.

Some of these having been cautiously try'd, by those who had a great desire to find them true, have not succeeded at all in practice. Hence we have so many complaints of such chymists as have lost their labour in endeavouring to make, according to *Beguinus's* directions, the mercury of silver; tho' I do not take that to be one of the most difficult to be prepared: and he who converses with those who have attempted to make the mercuries of gold, antimony, &c. according to the vulgar processes, will find, by their confessions, how little the event has answer'd their expectations. Nor do all the manuscript processes, communicated to private friends as great arcana, much excel the other; as several of my acquaintance have found to their cost. Among the many chymists I have known, I remember not above three or four credible persons who would affirm, they had ever prepared the mercury of any metal or mineral, except of native cinnabar, which is the natural ore of quick-silver; or seen it made, in a constant way, by any process found in printed books. So many of these methods having, therefore, upon trial, been found false; cautious men may be excus'd believing other processes for making mercury, which, tho' not yet try'd, seem no more probable, than those that have been found unsuccessful.

But farther; there are some processes, wherein it is thought, that the mercury of a metal, or mineral, is obtained, when, indeed, the produced substance is miscall'd; or the true mercury said to be extract-ed, was put in disguiz'd by the operator.

I will not here give instances of the cheats that may be put upon the ignorant and unwary, and sometimes too upon the skilful, if they be not cautious; but shall content my self with a few innocent examples.

And,

And, first, there are some, who finding themselves unable to make the true mercuries of metals or minerals, ascribe the name of mercury to productions, whose qualities are very remote from those agreed to be essential to quick-silver. Thus *Glauber* speaks much of his mercury of *Luna*, which yet is far from being running mercury; or having the ponderosity, and other properties of true quick-silver. So *Angelus Sala*, in his anatomy of antimony, would have us to look upon the regulus of that mineral as its mercury; because he takes it for granted, it must contain mercury; and fancies no other can be obtained from it. To shew that the mercury obtained by some processes which seem to succeed, made part of the addition employed by the artist in the operation, I might have recourse to an easy instance, a deluding experiment that I made, by mixing the filings of copper with a certain salt, and putting them in a glass vessel held over the fire, till the salt is thoroughly melted, and in part sublimed; by which operation, the copper seems to be quite changed, especially in colour; while there remains in the lower part of the glass a considerable quantity of running mercury.

Lastly, it is possible to obtain from some metals and minerals true running mercury, or quick-silver, that cannot justly be thought to proceed merely from the addition.

Having distilled copper with certain saline substances, I was not a little surprized to find, in the vessels that had been luted together, some globules of running mercury, which I could not reasonably suspect to come from the addition, that was not sublimate; nor any thing I could judge to contain quick-silver. I afterwards found, that accidents of the like nature had been observed by several of my friends.

A chymist of my acquaintance pressing me to communicate to him a way of making the mercury of antimony and of lead; to be rid of his importunity, I told him what, on a sudden, came into my thoughts; and after I had forgot this affair, he came with great joy, to return me thanks for the instructions I had given him; bringing along with him some mercury of antimony, and a little mercury of lead, that he had already made by the help of them. And by the same means he expected to obtain much more mercury from the minerals, when they should be longer digested with the concurrence of the air in those salts, that I had advised him to grind therewith.

Two gentlemen of my acquaintance, tho' unknown to each other, working, almost at the same time, upon silver, found parts of that metal turned into running mercury; with which odd accident each of them came to acquaint me; bringing along with them a little portion of the mercury. One of the parcels I found not to be common, but metalline mercury; and the artist complained to me, that he sometimes had considerable quantities of it, to his great loss; because much of the silver he employed, in an operation that he expected would prove gainful, being turned into quick-silver, had swallowed up all his profit:—  
and

*Chymistry.* and this invited him to apply himself to me, hoping to find a remedy for this inconvenience.

A fellow-traveller of mine, employing a saline body about lead; after he had finished his operation, left the lead and salt together, for some months, in a vessel, which he laid by in a garret, where the air had access to it; and he afterwards found, to his wonder, that tho' he had employed no mercurial body to work upon the lead, yet part of it was turned into quick-silver, separable by straining; and more seemed in a ready disposition to undergo the like change. Whereupon he brought me a part of the metal, and a little of the mercury, which I found, by experience on gold, to be of a nobler kind than common mercury. And I the less wonder'd at this phenomenon, because, by examining the gentleman, I discover'd, that the principal thing he employed in the operation was common salt.

We took three ounces of well refined silver, in thin plates, and six of common sublimate, which was put first into a retort; the silver cut into small pieces, being laid uppermost, that it might be penetrated by the ascending fumes: but the fire having not been made strong enough, the sublimate was elevated to the upper part of the retort, and left the silver scarce at all chang'd in the bottom of the glass. Wherefore, we put the same sublimate and metal into another retort, and applying a stronger fire, that the sublimate might be thoroughly melted before it could fly away, we obtained no running mercury at all; but the greatest part of the sublimate was elevated in its usual form; leaving behind it, the silver in a lump, which stuck hard to the bottom of the glass, and appeared much alter'd. It had gained an ounce in weight, and many pieces of the metal stuck together, and seemed at least half melted; and were of a kind of horny and semi-diaphanous substance, which would readily melt, almost like sealing-wax, when held to the flame of a candle, at which yet I could not perceive it manifestly to take fire.

An expert metallist of my acquaintance, being desirous to try what gold and silver he could get out of a fine *English* marcasite I had presented him; he examined it, according to his method, without any mercurial preparation, and found, to his surprize, that it yielded, besides other things, some running mercury, which he gave me.

More than one of my friends have made the mercury of antimony, by unsuspected additions, such as salts, that had nothing to do with sublimate, or other compositions, wherein common mercury is an ingredient. One of these antimonial mercuries looked so oddly, that, tho' it were made by distillation, I try'd whether it would not operate on gold in a peculiar manner; and having, accordingly, put a little fine calx of that metal into the palm of my hand, I added to it an equal, or a double weight of this mercury, which immediately incorporated with a very manifest heat. And this is my quick way of examining other mercuries of bodies; for tho' alone it be not a certain

*Metalline  
mercuries pro-  
duce heat in  
mixing with  
gold.*



certain sign, that a mercury is of that sort, because I can obtain a mercury so qualified, by a different method from any hitherto mentioned; yet as I had sufficient reason to conclude, that they obtained those mercuries from the bodies they affirm'd to have yielded them, so the readiness of these mercuries to mix with gold, without the help of fire, and even to grow hot with it, which vulgar mercury will not do, confirmed that they were metalline mercuries, rather than of the same kind with common quick-silver. And my way of obtaining incalcescent mercury, is so very different from any of those, that there was not the least cause to suspect, the mercuries of the respective bodies were so obtained; especially since I knew that my way was unknown to most of the persons mentioned, and practised by none of them.

Having prepared a particular mercury of this kind, I put to one part thereof, sometimes half its weight, and sometimes an equal weight of refined gold, reduced to a calx, or subtile powder; and mixing them together in the palm of my hand, they grew, in the space of a minute, considerably hot. The effect was by much the greater, for employing an equal weight of gold. Nor did the interposition of a paper between the metals and the hand, prevent, tho' it much abated, their heat.

These experiments were made but with small quantities of the mercury; but if we had employed larger, to a due proportion of gold, 'tis probable, the heat might have been intense enough to crack a glass vial; for a dram of it has sometimes caused me to lay it suddenly out of my hands. This mercury was so well disposed to gold, that it would presently amalgamate with an equal quantity thereof, into a hard mixture; wherein the mercury so far prevailed, as quite to abolish the colour of the gold. And the power of penetrating and growing hot with gold, was so essential to our mercury, that after it had been frequently distilled from that noble metal, it still retained this property: nay, even a single dram of it, after having lain by for three or four years, grew so hot with gold, that I feared it would have burnt my hand. And to try, whether this surprizing faculty of growing hot immediately upon gold, wou'd continue for a still longer time in the mercury; I took some that I had kept, hermetically sealed up, for ten or twelve years, and having put it to some common calx of gold in the palm of my hand, it presently grew hot: and having distilled off the mercury, and tried it again, it did, as well as some that was undistill'd, again heat with gold.

And, by the way, we may observe, that a mercury qualified to grow hot with gold, and perhaps with other powders, may be made by more methods than one or two; for experience has assured me, that such a mercury may successfully be prepared, not only by employing antimony, and such solid metals as iron, but even without any metal or antimony. But the gold must be duly prepared for this trial: the smallest filings I could procure, were not fine enough for the purpose. Nor will every calx of gold serve the turn; that which

Chymistry,

I principally chose, was made by quartation, or the melting together one part of fine gold, and three or four parts of cupell'd silver, and then putting the mass, wherein the metals are mixed almost *per minima*, into purified *Aqua fortis*, which dissolving only the silver, leaves the gold in a fine calx. But there being some difficulty in obtaining this calx pure, I will add, that by making an amalgam, in the common way, with pure gold and vulgar mercury; and dissolving the mercury in good *Aqua fortis*, there will remain a powder, which being well wash'd with fair water, and kept a while in a moderate fire to dry, will become a proper calx for this purpose. And to shew, that the heat in this experiment proceeds not from the corrosive particles of the *Aqua fortis*, employed in preparing the gold; I put upon fine leaf-gold, two or three times its quantity of our mercury, and a smart heat was immediately produced in my hand. I put two drams of antimonial quick-silver into the palm of my hand, and added to it, by degrees, a dram and half of the powder of fine silver, made by precipitation with copper, in the ordinary way; when mixing them with my finger, I found they grew sensibly warm. And this mixture, in a short time, became of a soft and uniform consistence, almost like melted butter; so that we added half a dram more calx of silver, without rendering the amalgam too stiff; and, perhaps, we might have added another half dram, without overcharging that piercing mercury; in which case it would have swallowed up full its own weight of silver: so different was it from common mercury. And when we left off, it had reduced into a very yielding form, three quarters of its own weight of solid metal. This amalgam we put into a small vial, and stopp'd it up with cork, to observe, whether it would harden when kept from the free air. Next morning it appeared to be concreted in the glass; and breaking the glass on the morning following, to take out the matter, we found it considerably hard and brittle.

As for the mercury of gold, tho' I have brought a great many parts of that crude metal to assume a mercurial form, and to come over therein by distillation, yet I have not seen any thing, that I was satisfied deserved to be called mercury of gold. But a foreigner, who seem'd a candid gentleman, and, as I perceived, had seen uncommon things, and who shewed me one whereat I was surprized, assured me, that he had met with a very learned man, in comparison of whom he confessed himself but a novice, who put some gold into a little vial of a certain menstruum, which this gentleman knew not how to prepare; and intimated to him, that the menstruum would have a peculiar operation, as well upon gold as silver; and my relator having put the vial, well stopp'd, into his pocket, and carried it about with him, was, when he came home, and took it out, surprized to find, instead of the gold he had seen put in, a considerable quantity of running mercury. This the artist, who only lent him the men-

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menstruum, did not seem to think strange, when made acquainted *Chymistry.* with it.

I have here been careful to mention only those relations, to which I my self saw cause to give assent. If these instances be supposed casual experiments, whilst there appears no settled way for the obtaining the mercuries of bodies, I might alledge, that some passages here deliver'd make it probable, that even settled methods of making the mercuries of some bodies, are not unknown to some artists. And tho' most of these experiments may be said to have been casual in this respect, that those who made them did not principally design to obtain metalline or mineral mercuries; yet the effects produced were as naturally and necessarily consequent upon operations so managed, as if the artist had directly design'd them; which in some of these cases they did. And it is not material to enquire, whether the quick-silver, made in those experiments, be owing to chance or skill; since it is plain, that if metals and minerals cou'd, by either way, be actually brought to afford running mercury; there needs no more to prove that such mercuries are really obtainable from them.

Whether the mercuries of metals and minerals be pre-existing principles, and only extracted from them, may seem superfluous to enquire; since the generality of chymists, of different ages and countries, have resolutely determin'd the affirmative. This, however, is not at all to be wonder'd at, since, according to their hypothesis of the *tria prima*, whereof they presume all perfectly mix'd bodies to be composed, metals must consist of mercury, as well as of salt and sulphur; and consequently afford it upon the analysis of the body into its three primordial ingredients. But notwithstanding this, the problem seems difficult to be resolv'd: for supposing there are true metalline mercuries preparable by chymists; they very studiously conceal the ways of their preparation. And as 'tis very difficult to obtain any of the factitious mercuries, wherewith to make the proper tryals; so those few authors who affirm themselves to have possess'd such mercuries, give us but an exceeding lame and defective account of them; studiously omitting those particulars which are most requisite in order to form a right judgment about them. For my own part, I am, at present, inclin'd to think, that the mercuries obtain'd from metals, do not clearly appear to have been pre-existent in them; and that, at least, some of them, may be rather fluid magisteries of metals, than their principles. One of the most obvious things that suggested this suspicion to me was, that whilst some metals, as tin and lead, were in fusion, they wou'd to one, who shou'd not know of their being melted, appear to be parcels of mercury; since, like it, they are fluid and ponderous, and stick not to the crucible, or to stones, bricks, or almost any other bodies, except metalline ones; some of which they will easily pierce into, as quick-silver does into silver or gold; so that if the fluidity of these metals were permanent, they might well



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pass for mercuries. And if in the moon as there are mountains, so there shou'd also be metalline mines, in case the heat of the climate, or of the soil, shou'd keep them constantly in such a degree of heat, as we find sufficient to melt lead, which need not be very intense, these metals wou'd there imitate our mercuries. Thus I have learn'd from travellers, that in several parts of the torrid zone, what would here be butter, is there fluid like oil, and sold, as other liquors, by measure, not by weight. And an inquisitive traveller assured me, that whilst he was in some parts of the *Indies*, having furnish'd himself with some liquid substances from wounded plants; as soon as he came near *Europe* they turned into consistent and pulverable bodies: it is not therefore impossible, that the piercing salts, and other subtil bodies, employed in preparing the mercuries of metals, may, either by their natural agility, and by so altering the shapes, and loosing the cohesion of the metalline corpuscles, bring them to such a texture as may suffer the ethereal substance, whereto so many other bodies owe their fluidity, to agitate them. These causes, or some other, may possibly keep the prepared metal fluid. Thus tho' camphire be a consistent and tough body, yet some nitrous spirits will easily penetrate it, and may be brought to stay so long with it, that I have kept the oil of camphire for several years, without loss of its fluidity, tho' expos'd to such intense degrees of cold as would freeze several other liquors. And since the vapour of lead can arrest quick-silver, and make it a consistent body; and since *Helmont* assures us, that the liquor alkalest being once abstracted from running mercury, deprives it, and that almost irrecoverably, of its fluidity, so as to make it pulverable; why may not nature or art supply some corpuscles to expel or disable those that keep a metal in the form of a solid; especially since the matter of metals themselves may have been a fluid body. Another reason why I suspect the mercuries of metals and minerals not to be merely extracted principles or ingredients, is, that I have observed a greater dissimilitude between running mercuries, furnished with all that is requisite to make them pass for true, than agrees to their being simple and primordial bodies, barely extricated from the others, with which they were at first mix'd; as we shall see hereafter. The chymists, also, who talk of the mercuries they have drawn from metals, do not tell us what other ingredients they obtain'd by their supposed analysis; which leaves it dubious, whether they obtain'd any salt or sulphur or not; and of what nature those substances were that they did obtain. For if these were not true salt and sulphur, the genuineness of the analysis might be question'd; because it may be alledg'd, that the chymical operation, and the addition, turning some parts of the earth into bodies, which must not be acknowledged to have pre-existed in them, may also, by a change of texture, have turn'd some other parts of the metal into the form of mercury.

And

And to give the sanction of an adept, *Raymund Lully*, tho' he often speaks of mercury in a dark and allegorical sense, yet in his *Clavicula*, he delivers a process, from whence it seems manifest, that his design was not to extract a pre-existent quick-silver; since he directs us to prosecute the work till the quick-silver obtained, be equal in weight to the silver to be transmuted; whereby it appears, that the mercuries of bodies are rather magisteries than extracts. For in this process of *Lully* it appears not, that the mercurial principle was extracted from the salt and sulphur; but rather that the body of the metal, without being analyzed, was turn'd into mercury. Magistery is, indeed, a term variously employed by chymists, and, particularly, 'tis used by *Paracelsus*, to signify different things; but the best notion I know of it, is, that which I find authoriz'd even by *Paracelsus*, where he expresses himself more distinctly, I mean, a preparation whereby there is no analysis made of the body assign'd, nor an extraction of any particular principle, but almost the whole body is turn'd into a substance of another kind: as when iron or copper, by an acid menstruum that corrodes and associates therewith, is turn'd into vitriol of iron or copper; and quick-silver, by having a sufficient quantity of *Aqua fortis*, strongly abstracted from it, is chang'd into red precipitate; or by being sublim'd with common sulphur, is turn'd into cinabar: or to give a more apposite example, when quick-silver is, by the lasting operation of the fire, without external additions, distinct from the particles of fire, turn'd into a red powder, call'd precipitate *per se*.

I am credibly informed, and have some proof of the thing, that there is a place in *Transylvania*, where portions of running mercury falling out of the earth, and lying a while in the air, of themselves coagulate into bodies permanently hard: so little difference hath nature her self there made between the mercurial fluidity, and the solid consistence of the same portion of matter. If, therefore, so small a thing as the contact of the air can expel, is able, by its presence, to retain a mineral body in the form of a true running mercury, as well as by its recess to leave it solid; why shou'd it be impossible for art to interclose some very minute and restless particles, which, by their various and incessant motions, may keep a metalline body in the state of fluidity; as I lately noted, that the spirit of nitre, for whole years together, kept camphire in the form of a liquid oil?

But it may be objected, that quick-silver easily amalgamates with metals; because of its near alliance to the mercurial part of those bodies, and that the gravity of the metals is such, as cannot reasonably be deduced from any other cause than an abundance of the mercurial principle.

To this I answer, that amalgamation being, in effect, but a kind of dissolution of metals, in a menstruum or fluid body, for such is mercury with regard to them, there is no necessity that the solvent shou'd find, in the metal, a copious ingredient just of its own nature; for dissolution depends not so much upon the pretended affinity between

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It may, again, be objected, that the mercuries of metals must needs be but partial principles of them; since quick-silver being confessedly heavier than either the sulphureous, or the saline principle, and than almost any metal; the gravity of a metal cannot reasonably be supposed to proceed from the whole body of it, but only from some one ingredient, heavier *in specie* than the rest, and than the metal it self. And that this ingredient, or principle, can be no other than the most ponderous body, mercury.

But there is no necessity to suppose, that metals, of what denomination soever, are bodies perfectly homogeneous, tho' they seem such to the eye; and the chymists will have metals, as well as other mix'd bodies,



bodies, to consist of three hypostatical principles, whereof mercury is one; altho' it must be much heavier *in specie*, than either the salt, or the sulphur, wherewith it is blended; for from the participation of that ingredient, they derive the great ponderosity of metals.

And, perhaps, the more solid and heavy particles of a metal, may lie, not in the form of fluid or mercurial, but consistent parts; and these may be more disposed than the rest to be brought, by chymical additions, and the operation of the fire, into the form of a running mercury. Nor ought it to be judg'd incredible, that such a solid portion of the metal should be more ponderous than quick-silver; since, as I have often try'd, solid gold is far heavier than quick-silver; to the bare participation whereof that noble metal cannot owe its specific gravity.

Upon this supposition it will be easy to say how the mercury of a metal may be heavier *in specie*, than the metal that afforded it; for the solid parts, which, by the chymical operation, are reduced into the form of quick-silver, are then far more ponderous in kind, than the other parts of the metal; which being also associated with them, make, by their comparative lightness, the entire metal less heavy, than an aggregate of all the solid parts alone. Thus I have observed a decrease of specific gravity in quick-silver, when united, by sublimation, either with sulphur into cinnabar, or with salt in corrosive sublimate.

It might, however, be alledged, that the mercuries of metals being in a liquid form, cannot well be supposed such close and ponderous bodies as our hypothesis requires; and that we our selves admit an experiment of *Raymund Lully*, whereby he pretends to reduce the whole body of silver into mercury, which is a heavier substance than silver; in which case we cannot say, that the corpuscles which assume the form of mercury, were far more ponderous than the others, that concurred with them to compose the metal.

I reply, first, it is very possible that a large quantity of an addition may be employed in preparing the mercury of a metal, and yet there will really and finally adhere to the metalline parts, but a very small proportion of it, which may continue therewith, and keep them in a mercurial flux. That a very small quantity of additional matter, may have a very great power in altering the consistence of what is obtained from a metal, as its most ponderous portion, appears from the bare accession of igneous particles, which is able, in time, to turn running mercury into that red powder, called precipitate *per se*: and I have found, by trials purposely made, that this powder, without any further addition, may be reduced into running mercury. And *Helmont*, as we before observed, relates, that by the abstraction of the liquor alkahest, which comes all over in distillation, from common quick-silver, he turn'd it into a fix'd body; whereby we see how little a quantity of matter will serve to change the consistence of a mercurial substance.

Besides,

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Besides, a fluid form does not always argue the lightness of the body wherein it is found; since it may consist of particles so solid and numerous, that notwithstanding their intestine motion, the body they compose may be very ponderous; as appears by red-hot iron, melted lead, and in common quick-silver, which, tho' fluid, is heavier than any known body except gold.

But farther, tho' the solid portion of a metal retain more of the additions employ'd to bring it into the form of mercury, than it can be prov'd to contain; yet, this disadvantage may be compensated, by the new disposition of parts that the mercurial portion acquires in the operation which turns it into a liquor; and may be suppos'd to bring the parts to a closer, or more convenient order than they were in before; as ice, when thaw'd, takes up less room than when solid. And 'tis not impossible, that the specific gravity of metalline bodies may be increas'd or diminished by such small proportions of additions, as do not at all considerably add to their absolute gravity. This the chymists ought not to deny, after what they grant of the efficacy of that they call the philosopher's stone, whereof they tell us, that one grain, if it be of a nobler order, or degree, may transmute a whole pound of quick-silver into perfect gold; whence, consequently, the specific gravity of a metal is vastly chang'd by an addition. Besides, the transmuting powder, being a compound body, whereof only a part is gold, it may probably be suppos'd to be more light *in specie*, than the metal, that by addition thereof is produced; which being pure gold, is the most ponderous body yet known. And there is a way of making a metal far lighter *in specie* than it naturally is, by the addition of less than a 100th part of its weight; as experience has convinc'd me.

Wherefore, to come to the grand objection drawn from Lully's experiment, it will not presently follow, that, if the whole body of a metal be brought into a mercurial form, this mercury destroys our hypothesis; for tho' I grant it cannot here be said, as in the former cases, where a part only of the metal is turn'd to mercury, that the obtain'd quick-silver may consist of the most solid and ponderous parts of the metal; yet it may still be alledg'd, that, for ought we know, the mercury produc'd by the reduction of the whole metal into a fluid form, will be specifically lighter than common mercury; and so cannot be necessarily concluded specifically heavier than the metal that afforded it. I have, indeed, had portions of the mercuries of more than one or two metals, yet it was but in small quantities; so that the other trials I made with them, prevented me from examining their specific gravity hydrostatically. But, that quick-silver may be specifically lighter than the metal which affords it, the chymists cannot reasonably deny; since they allow running mercury to be obtainable from gold; and tell us great matters of it, because of its proceeding from so noble a body. Now, if this mercury of gold be said to be of the same specific weight with common quick-silver, we have a notable instance of a mercury considerably

derably lighter, *in specie*, than the metal that yielded it. And therefore, till experience has manifested the contrary, it will not be absurd to presume, that the mercuries of other metals may, likewise, be lighter, *in specie*, than the respective bodies from which they were obtain'd: but if it be said, that this mercury of gold, may be as ponderous as gold it self; then 'tis possible for a metalline body, notwithstanding its being reduced into the form of a fluid, to be equiponderant to the metal that afforded it. And to confirm this, I shall add, that it is possible for a metalline body to resemble another in all the manifest qualities whereby artists examine them; and yet to differ greatly from it in specific gravity; as I once observed in a metal, that was not only white, like silver, and very malleable, but when purposely examined, endured cupellation, and was reputed by a very eminent artist, who sent it me to examine, to be good silver in all proofs; and yet this metal I found, by hydrostatical trials, to be much lighter, *in specie*, than common silver. And if this famous person was not mistaken, that odd metal may yield me a notable instance to my present purpose; since he affirm'd it to be made of quick-silver, without the addition of any metalline body: for if so, that fluid must, by a change of texture, have suffer'd a considerable loss in its specific gravity. And once I had a mercury, which, amongst other remarkable properties, was considerably heavier, *in specie*, than common mercury, tho' it were made of a body no heavier, and by the help of additions much lighter than that. This quick-silver looked very fine, was very agile, and had, before I examined it, been more than once distill'd. Hence it appears, that while a body is in a mercurial form, we cannot safely determine what degree of specific gravity it has. For since a sort of quick-silver may be far more ponderous than the common; 'tis probable, that another sort may be far lighter than that; and so, perhaps, lighter than the metals reduced into that form: for 'tis far less likely, that the former should be produced, than the latter; because there is but one known mineral body at all heavier than common quick-silver; whereas there are many much lighter than it, which are capable of being associated therewith.

In short, the argument I have been answering is not cogent, because built upon a supposition, that the mercuries afforded by metals and minerals must be of the same weight with common mercury; which is a bare assertion, without any proof, and repugnant to the experiment just mentioned, of the distilled mercury, that was heavier than the common; and to the presumption thence derived, that there may be bodies in a mercurial form, lighter, *in specie*, than common mercury. And since pure gold is far more ponderous than common quick-silver, it plainly appears, that it is not to the participation of common mercury, that metals must necessarily owe their great weight; but that nature and art may contrive the parts of a body into so close an order, as to make it more ponderous, bulk for bulk, than common quick-silver.



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*Running mer-  
curies not ho-  
mogeneous.*

And here it may be proper to inquire, whether all the bodies, that in shops, and among chymists, pass for true running mercuries, are homogeneous, or, so much of one and the same nature, that the several portions of them differ but numerically.

I have some observations to make upon this question, that will determine it in the negative; tho' both chymists and naturalists employ all running mercuries indifferently.

1. And, first, it is observable, that a running mercury may be brought to differ from common quick-silver, by depuration; for there are in most mercuries, either recementitious particles, or at least some loose adherences, separable from the rest of the body; which being removed, the mercury becomes more homogeneous, or clean, than before. The like end is also obtainable, by grinding, or washing the mercury very well with salt and vinegar, or spirit of wine; which will commonly be foul'd by what they carry off. And mercury is sometimes attempted to be purified by distillation; which, tho' in some cases insufficient, is in others very convenient. And artists use other means to the same purpose. No wonder then, if chymists themselves, before they proceed to more intimate preparations of mercury, order it to be, several times, previously incorporated, and sublimed with acid salts or sulphurs, and then revived with alkalies; since, according to mechanical principles, it must thus be divided into exceeding minute globules; whence it acquires far more of surface than it had before; so that a great multitude of separable parts come to be touch'd almost on every side by the salts and sulphurs, whereto, by this means, when the quick-silver is driven from them in the revivification, 'tis probable, that very many of them adhere, which were not superficial, when all these globules made up but one mass. And, 'tis possible too, that the alkalies employed to revive the quick-silver, may help to tear off from it some of the feculent particles, which the chymists desire it should be freed from. And, by the way, there is no necessity to have recourse to salt of tartar, or quick-lime, or such like alkalies, for the reviving of quick-silver; and, therefore, when I would, with ease, obtain a clean and active mercury, I do not employ first acid, and then alkaline salts, but thoroughly mix common cinnabar, finely powder'd, with a double, or an equal weight of filings of iron, or steel; for these being distilled together in a low retort, with a brisk fire, the sulphur of the cinnabar will fasten upon the filings, and let the mercury come over fair and vivid, and, perhaps, impregnated with a ferruginous quality.

2. There is, also, another way of diversifying mercury by impregnation; as when some subtle parts of another body, are so intimately associated and united therewith, that not only the addition will pass with the mercury, when strained thro' leather, but, also, continue with it after distillation, whilst the mercury still remains very vivid. I know there are many chymists, who look upon quick-silver

as a mineral, wherein no other body can fasten, so as to alter it intrinsically, or suffer it to be associated intimately, or permanently therewith. And, indeed, since we find that when gold it self, where-to, of all bodies whatsoever, mercury is allowed to have the greatest analogy, may yet be separated from it, by committing an amalgam of those two metals to leather; which will transmit the quick-silver, and retain the gold; and since if such an amalgam be distilled with a competent fire, the mercury will ascend, and leave all the gold behind in the retort; it seems improbable, that mercury should be more intimately associated with any other bodies: but these arguments, tho' specious, are not satisfactory; for the corpuscles of some mineral bodies may be so well mixed with quick-silver, as to pass with it through the pores of leather; and I have found, by trial purposely made, that quick-silver being in a convenient proportion amalgamated with tin or lead, and distilled with a competent fire, will manifestly bring over with it some of the associated metal; so that I have not only found a considerable increase in the weight of the distilled quick-silver, but it would both leave a tail behind it upon a sloping glass; and when this sluggish mercury had rested a while, it appeared cover'd over with a kind of scum, made of the emerging corpuscles of the tin or lead; either of which, especially the former, is a metal lighter, *in specie*, than quick-silver. Hence it appears, that mercury may be so united to a considerable proportion of a gross, ponderous body, of an ignobler kind, as to carry it along with it self in distillation; which, therefore, seems not to be near so certain a way, as some learned chymists think it, to try whether mercury be pure; and to free it from adulterating mixtures. Since we see then, that mercury does not refuse even gross impregnations, it is not incredible, that it may, in some cases, admit more subtile ones; and so intimately associate with it self some of the finer parts of certain metals and minerals, as not to part with them by distillation, or repeated ablution. I had once a distilled mercury, made by an impregnation of common mercury, a globule whereof being evaporated from a thin piece of silver, not only seemed to have penetrated the plate, but left upon it a rugged substance, of a colour very near that of gold. But that common mercury may be impregnated with fine particles, I have been persuaded by several effects of such impregnations: and most of the uncommon mercuries, I shall hereafter mention, were prepared after some such manner.

3. Another thing wherein a mercury may differ from common quick-silver, is a facility to amalgamate with gold; for, 'tis known to gilders, goldsmiths, &c. that to make amalgams with gold and mercury, 'tis usual to take six parts of the latter to one of the former. And notwithstanding so large a proportion of mercury, they make both that and the gold considerably hot to facilitate their mixture; but I have often had subtilly impregnated mercuries, with but two parts thereof,

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I could presently make an amalgam with one part of the calx, or leaves of gold, without any other external heat, greater than that of the palm of my hand. Nay, sometimes, I have employ'd but one part of quick-silver to make a mixture; wherein the gold was so far from appearing, that the colour of the quick-silver seem'd not sensibly impair'd.

4. Another difference between some mercuries, and those that are vulgar, is, that these being put to calx of gold, tho' they are, at length, brought to mix, yet they will not disclose any sensible heat; but the mixture, like each of the incorporated ingredients, will to the touch seem cold. But I have often found, that a distill'd mercury may be so invigorated, that a single dram of it, or, perhaps, a far less quantity, being barely mix'd by my finger, with as much, or half as much calx of gold, would presently conceive a considerable heat, which would, as was formerly said, sometimes, prove offensive to the palm of my hand, wherein I held it. And to convince a very eminent chymist, that there were such mercuries as these, I took a remnant of certain quick-silver, of whose disposition to incalcescence I had such an opinion, that tho' we had no calx, nor so much as filings of gold, but only such pieces as could be obtain'd by a hammer and a pair of scissars; I ventured to put it to them in a glass mortar, when, notwithstanding the thickness and closeness of the beaten metal, and the coldness of the vessel, the mercury, to the artist's surprize, penetrated the gold, and grew manifestly hot with it. And this faculty of our quick-silver was not transient; for I had kept this parcel of it by me for several years. The incalcescent mercuries, hitherto mentioned, were invigorated by tedious and laborious operations; but I know, by experience, a way, tho' it be hard to hit, that will in an hour, and perhaps in less time, qualify mercury to grow presently hot, tho' in a manner vastly inferior to the former.

5. When an invigorated mercury is, by due impregnation, qualified to amalgamate readily and intimately with gold, and penetrated so as presently to grow hot therewith, it is not strange that it should also differ from common mercury, in being able to carry up with it part of the gold, wherewith it was so strictly associated. I know, 'tis often thought incredible, that crude gold should be volatiliz'd by quick-silver; and, indeed, the common sort may be many times distill'd from gold, without carrying up any of it; but with a very small quantity of a mercury, subtilly impregnated, I have elevated so much calx of gold, that the inside and neck of the retort, were richly gilt by the adherent particles of that metal, which would sometimes stick so close, as not, without difficulty, to be separated from the glass: and having, with one of these noble mercuries, amalgamated about half its weight of calx of gold, tho' it did not gild the inside of the glass, yet I found, that the distill'd mercury was manifestly increas'd in weight, and somewhat changed in colour and consistence.

6. Upon



6. Upon distilling an amalgam, made with one of these subtilly impregnated mercuries, and the calx of gold, I have observ'd a large part of the bottom of the retort, to be left adorn'd with a very lovely colour, almost like that of a turquoise stone, inclining to yellow, and somewhat changeable; and the stain seem'd to have penetrated the glass, tho' left by a very small quantity of the amalgam; and tho' the mixture were distill'd but in a sand heat. And another amalgam of gold, with an invigorated mercury, being long decocted, the vessel broke, and left the lower part of the glass permanently ting'd with a pure and transparent red, that seem'd to resemble a fine ruby.

7. I have found another surprizing difference between ordinary quick-silver, and subtilly impregnated mercuries; for tho' one would expect that mercuries so piercing, and so dispos'd to adhere closely to gold, should make with it amalgams, far more easy than those made with ordinary quick-silver, to be turn'd into red precipitate; yet I found the contrary upon trial. Chymists mention about six weeks, as the usual time wherein mercury may be precipitated *per se*; and allow but a shorter time, to make this precipitation, when 'tis amalgamated with gold; but I have kept invigorated mercury, amalgamated with about a third part of its weight of fine gold, for above three months, without having so much as a grain of precipitate, that I could perceive; tho' the mercury grew hot with the gold at their being mingled, and tho' the whole were kept in a heat, able to make quick-silver circulate. This I try'd with other sorts of invigorated mercury; but, in above five or six months, obtain'd not a single grain of precipitate; tho' the heat was so strong, as to carry up many parts of the quick-silver, and of the gold with it, to the top of the glasses. Nay, the fire was so violent, that one of the hermetically seal'd glasses beginning to melt, the spirituous matter, included in it, was so forcibly expanded, as to stretch the weaker side of the vessel, and make it bulge out; tho' it did not break. Nor is the space of six months, the longest term, during which I have kept gold in decoction with invigorated mercuries, without obtaining a red powder, or precipitate; so that as far as I have yet try'd, the more subtil, and richly impregnated mercuries, are far less apt to afford precipitates with gold, than common quick-silver is. As if that disposition, to be turn'd into powder, required the presence of the recrementitious, or more separable part of quick-silver, which a chymist would perhaps call its sulphur. This, I confess, was a disappointment to me; for I had hopes of making a precipitate with gold, and some of these noble and richly impregnated mercuries, that should prove a better medicine than precipitates made with gold and only common mercury; tho' even of some of these, when dexterously prepared, and kept their due time in decoction, I have seen great effects, when exhibited in a just dose, and prevented from raising a salivation.

8. The last difference I shall observe between some distill'd mercuries and common quick-silver, is their inequality in point of specific gravity.

I had

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I had once the opportunity to examine, hydrostatically, a noble mercury, for the impregnating whereof, neither gold nor silver was employ'd, and I found it very considerably heavier, *in specie*, than common quick-silver; tho' this mercury had been several times distill'd, and by other means depurated; which to me seemed to argue, that even volatile gold is able to increase the specific gravity of mercury. And the ponderosity of this mercury seems more surprizing, because having, by the same method, examined another, made after a strange way, without common mercury, I found it scarce at all to differ in gravity from ordinary quick-silver.

And, by the way, 'tis no just inference, the heavier the mercury, the more fix'd; for having instructed a gentleman how to make an invigorated mercury, which I judg'd to be much of the like nature with our ponderous one, but less tedious, and far less difficult to prepare; this gentleman inform'd me, that in purifying and invigorating his quick-silver, he found it so alter'd and subtilized, that he could distil it in less than half the time, he had formerly employ'd to drive it over, with the like fire and vessels.

And whatever some learned chymists, and others, teach to the contrary, it is matter of fact, that mercuries may be subtly impregnated more ways than one, so as to penetrate gold very powerfully, and grow hot with it. And it seems to me very probable, that the different methods employ'd to prepare these mercuries, by impregnating them with a particular mineral or metal, may much diversify their qualities and operations, according to the respective natures of the bodies made use of. And tho' there seem so great a difference between quick-silver and vegetable substances, yet I have seen a mercury that was prepared by the help of vegetables, without metals or minerals, more noble than, and very different from common quick-silver. And as several bodies and methods may be employed in the preparation of noble mercuries, so it seems very probable, that the common mercuries, thus prepared, may have different, but noble qualities and uses, not only in chymistry, but medicine; as being fitted for powerful operations, as well upon human bodies as the more stubborn ones of metals and minerals. I am not, indeed, forward to recommend the needless use of mercurial medicines, of which we may too often see bad effects, if they be not as well prudently and cautiously given, as faithfully and skilfully prepared: but since some vulgar preparations of common mercury often prove far more efficacious than ordinary medicines, in stubborn diseases; we may, surely, hope for greater and more innocent effects from a mercury, well purify'd and impregnated with the sulphur and finer parts of such bodies, as volatile gold, copper, iron, antimony, &c. And tho', as I lately said, I found such mercuries much more indispos'd than common quick-silver, to make a precipitate with crude gold; yet several other preparations may be made, as well with impregnated, as with vulgar mercury; such are turbith mineral,

neral, the white precipitate, *Mercurius dulcis*, pills of crude antimony, or *Pilula Carulea*, and especially the cinnabar made by subliming quick-silver and sulphur into a purely red substance; which, tho' employ'd chiefly by painters, ought not to be neglected by physicians; since even in ordinary cinnabar the vulgar mercury is so bridled by the common sulphur, that unless too frequently given, without pauses, or in an indiscreet dose, it has not been usually found to salivate; yet it often lies not idle nor useless in the body: so that it may be well worth trying, whether a noble cinnabar may not be obtain'd by substituting animated mercury for vulgar; especially if instead of common sulphur, that of antimony, or of antimony and vitriol, be employ'd.

And here I must observe, that we shou'd not be hasty to conclude a mercury, which has been carefully depurated and impregnated, has not been well prepared, if we find it not readily elevate crude gold. For tho' I have had some mercuries fitted to penetrate gold so far, and mix with it so closely, that it wou'd quickly, upon distillation, visibly carry up some of that ponderous metal with it; yet so much is not to be expected from all invigorated mercuries. For I have found, that some, even of these, may require a strong decoction to incorporate them intimately with gold: and I once caused a mercury, which, upon bare distillation, wou'd not at all colour the glass, to unite so closely with the metal, by circulating it with the gold for a fortnight, that it wou'd afterwards elevate enough of it to gild the inside of the glass; and by a much longer decoction, I have, sometimes, had the gold plentifully lodg'd in the upper part, and even in the neck of considerably tall glasses, hermetically sealed.

## SECT. V.

**O**F the several substances that chymists obtain by the fire from mixed bodies, that which they call phlegm or water, seems to the *Helmontians*, and other modern artists, to bid the fairest for the title of elementary and primordial. Let us, therefore, examine, whether this phlegm pre-existed in the body whence 'tis obtain'd, in the form of simple water. Phlegm producible.

In order to this inquiry, I must premise, that in case some of the produc'd liquors, we speak of, shall be denied to be precisely of an elementary nature, we may still allow them the name of phlegm, provided they be not more remote from simplicity than those to which the chymists grant that appellation.

Now the two properties, upon account whereof chymists call a body phlegm or water, are its appearing to them insipid, and its being of a volatile and fugitive nature. I shall



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I shall not here observe the different tastes of different creatures, or of the same at different times, and according as the object is applied; but methink the consideration of quick-silver may let us see, that 'tis possible for a gross and fluid body to be insipid. For quick-silver is, without question, a fluid, and in regard to some bodies, as gold, silver, &c. a liquor; since it soaks into their pores, and softens their bodies. The same quick-silver may shew, by its disposition to fly away in the fire, that volatility, even in conjunction with insipidity, is no certain mark of an elementary or primordial body. And indeed, since volatility principally depends upon the extraordinary minuteness of the particles whereof a body consists, on their being detach'd from one another, and of shapes fitted for motion; this quality may be acquired by so many different ways, and be met with in bodies otherwise of such different natures, that unless it be found associated with the other qualities proper to phlegm, it will be but an uncertain argument to prove the body, it belongs to, elementary.

Of all the bodies employ'd in chymistry, those that seem the most indisposed to be turn'd into water, are metals and minerals; if, therefore, it can be made appear, that any of this sort are changeable into an aqueous liquor, 'twill be highly probable, that aqueous liquors may, by chymical operations, be produced, especially in vegetable and animal bodies, which seem far more susceptible of such a change, than the stubborn subjects of the mineral kingdom. And since quick-silver is generally allowed to be one of the most indestructible bodies in nature; and, by its great ponderosity, to be so much the more remote from such a liquor as water, that has not the sixteenth part of its specific weight; if this can be turn'd into an aqueous liquor, it will greatly favour our doctrine.

From quick-silver.

Relating to a very ingenious and sober physician of my acquaintance, that in distilling mercury, without addition, I once obtain'd a water, but could not make the like experiment afterwards succeed; he assured me, that he, and a friend of his, having provided a very large *Dutch* retort of good earth, furnished with a pipe, and, by degrees, convey'd thro' that pipe a pound of quick-silver into the retort, made red-hot, they obtain'd four ounces of water, and lost two ounces of matter; the remaining part of the pound being elevated in the form of mercury: and the receiver, he said, was not applied, till the retort had been made thoroughly glowing hot; so that this liquor could not be the aqueous particles of the earth of the vessel. He added, that the liquor was very different from common water; because, pouring both their distill'd mercury, and their water, into a kind of *China* cup, they left them open, in a garret, for two or three days in *June*, upon a presumption, that this mercurial water, thus order'd, would turn a part of the quick-silver into its own nature, and so multiply it self upon it; but coming to their cup again, they were much surpriz'd to find the water all gone, and the greatest part thereof turn'd into mercury; which they

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they concluded, because they mis'd, upon the balance, but about half an ounce of the whole matter, that was they suppoled to have been lost by evaporation; the other three ounces and a half being found in the additional weight of the mercury.

And trans-  
mutable into  
other bodies.

And if *Helmont* says true, that by his liquor alkahest, not only quick-silver, but all other tangible bodies, may be reduced into insipid water, just like rain water; I may infer, that water may be produced, since salt and sulphur themselves may be turn'd into it. I know the *Helmontians* might answer, that this is not so much a production, as a reduction, since all things consisting originally of water, the alkahest does but deprive it of the disguizes that seminal principles put it into, to make it appear under the form of gold, quick-silver, plants, animals, &c. But even by this answer 'tis granted, that water has actually been produced, in plenty, out of mineral bodies, tho' it has not yet been made appear, that those bodies were produced out of water. But supposing bodies, by the alkahest and the fire, were really reduced into water; *Helmont* farther relates, that by abstracting his immortal liquor from stones, or such kinds of bodies, he turned them into salt, equiponderant to the concrete; which salt, by further operations, he reduces, as he supposes, into elementary water. Since then he stops not at salt, but goes to a further transmutation; and concludes, that a stone doth not consist of salt, because that salt may be turn'd into insipid water; I say, that insipid water is not the first matter of bodies; since, by a farther operation of the fire, that liquor it self may be turn'd into earth. For clear water, several times very slowly distill'd out of clear glass bodies, has every time left me a terrestrial powder at the bottom; as if the whole body of the water might, by repeated distillations, without violence of the fire, be reduced into earth; whereof, in my last trial, I had enough to cover the bottom of a large cucurbit, out of which the distillations had been made.

And I shall here add an experiment, which seems to argue, that without the help of repeated distillations in tall cucurbits, clear water may, by the operation of the fire, be changed into another body.

We put very pure and limpid water, which had, by our pneumatic engine, been carefully freed from its aerial particles, into a new bolt-head, of such a size, that the matter might have room to play, and circulate; and sealing it up hermetically, we placed the vessel in a digestive furnace, and left it there above a year; and observed, that after it had continued for a considerable time, there began to form themselves in the water little concretions, heavier than it; which at length increased in magnitude, and, as we thought, in number; making a kind of *terra foliata*, that consisted of a multitude of little thin films, or scales, like those of the smaller sort of fish; which, when the glass was shaken in an enlightned place, were plentifully

## The Producibleness of

dispers'd thro' the body of the liquor, and appear'd variously and strongly colour'd; some whereof were almost as big as spangles, but more glittering: and when the agitation ceased, they presently fell to the bottom, and cover'd it. And the longer the glass was kept in the digestive furnace, the more of this fine terrestrial substance was produced. But lest the effect should be ascribed to the abstraction of the air, I must add, that we produced the like substance, tho' not so plentifully, after the like manner, in water that had not at all been freed from air.

## S E C T. VI.

Earth a heterogeneous principle.

OF all the substances obtainable from mix'd bodies, that which to persons, not prepossess'd with *Helmontian* opinions, may seem the most simple, elementary, and unchangeable, is, what they call earth, or *terra damnata*; because it seems highly probable, that the calcining violence of the fire, must not only have driven away the mercurial, and other volatile parts, but have quite burnt out the sulphurs, which are often more fixed than the rest; as the water, on the other hand, is suppos'd to have dissolv'd away all the fixed salt.

This reasoning, I confess, is plausible, but not satisfactory; for as the particulars wherein this supposed simplicity, and unchangeableness of the earthy part of mixed bodies is founded, are its not dissolving in water, its not affecting the taste, and its not having flown away from the incinerated body; it may, with probability, be doubted, whether any of these, or all of them put together, necessarily prove what the chymists pretend.

And producible.

And, first, according to the different constitutions of certain bodies, we must distinguish between the dry and heavy parts that remain, after a body has been expos'd to the violence of the fire; and, if need be, freed from its salt as much as possible, by the affusion of water. For 'tis evident, that in some bodies, especially of a metalline nature, the calcining fire does not operate, as in the burning of vegetables; since sometimes almost the whole weight of a mineral is to be found in what they call its calx; as is manifest in the calcination of tin and lead *per se*. And this calx is, in great part, reducible, sometimes into a body of the same nature with that which afforded it, and sometimes into another body, very far from being elementary, as appears in the reduction of minium; which, as to the greatest part of it, we have more than once, by the bare manner of ordering the fire, reduced, in a very short time, and without addition, into malleable lead; and also in the ashes of antimony, which, by bare fusion,



fusion, are easily reduced into glass; whence we have sometimes obtained an antimonial regulus. So that 'tis plain, there is a great difference between the ashes of metals, and of some minerals; where almost the whole body is, by the fire, converted into a dry and heavy powder, and the ashes of incinerated vegetables; which usually leave but little earth behind them, in comparison of the matter which the violence of the fire drives away.

But setting aside the metalline *Calces*, which, without question, remain compounded bodies, if metals themselves be so; and to forbear examining, whether they be not farther compounded with corpuscles of the fire or fewel; the qualities which make other ashes pass for elementary earth, may be produced in portions of matter that are not simple, either by composition, or change of texture.

There are substances, which tho' when single, they will easily dissolve in water, yet the result of them will not; whereof we have instances among the magisteries of several bodies, made by precipitating their solutions in acid liquors, with oil of tartar *per deliquium*.

*In various  
bodies.*

From oil of vitriol, and spirit of wine, tho' both most readily dissoluble in water, we have, by bare digestion and distillation, obtain'd a large quantity of a substance, that we found not dissolvable in water, insipid and fixed.

There are stones, also, which I could, by the help of the fire, deprive of their colour, and bring to a white powder; yet it did not appear, that they were really calcin'd, or would in water yield any salt. So that if stones be compound bodies, there may be other corpuscles, besides metalline ones, which, tho' reduced by the help of the fire to a white powder, insipid, and not dissoluble in water, are yet very remote from an elementary nature.

And chymists themselves teach us, that the ashes of wood may, by the violence of the fire, be turn'd into glass; which being a body compos'd of the earthy and saline part of the ashes, (for they say, that earth separated from the salt, will never vitrify,) must, according to their own confession, be a compound body; which being, at last, made by the utmost violence of the fire, must be fix'd, indissoluble in water, and consequently insipid. But without taking this vitrification upon the chymists authority, 'tis manifest, that in glass, made after the common way, there is a great deal of lixivate salt mixed with the sand; for artificers find the salt necessary to dissolve and fuse the sand: and the glass usually weighs sometimes thirty or forty pound in an hundred, more than the sand that was put in.

And since chymists ascribe all odours to sulphur, I may reasonably conclude against them, that, in spite of all the violence of fire, which is required to the making common glass, there is plenty of sulphur, as well as salt, in it; for I have often try'd, that by barely rubbing two pieces of glass one against another, there would quickly be produced a strong offensive smell. And yet glass, which thus appears to be not

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only a compounded, but a re-compounded body, (because the sand, and other stones, being themselves mixed bodies, are further compounded with the salts that dissolve them) manifestly possesses all those three qualities, which chymists require in their earth; for 'tis tasteless, indissoluble in water, and fix'd in the fire. And if ashes of themselves, be capable of vitrification, as chymists teach, and as the master of a glass-house told me he once found, with some difficulty; how are we sure, that in common ashes, freed, after the usual way, from their fixed salt, what is called a simple earth, may not be a body compounded of two or more substances, which, by their coalition and new texture, produced by the action of the fire, have been brought to a kind of vitrification; or have otherwise acquired the obvious qualities that chymists think sufficient to give a production of the fire the name of earth?

'Tis obvious, that several bodies, when of a sensible bulk, will sink in liquors wherein their corpuscles would freely swim, if many of them did not stick together. Thus lumps, and the grains of salt and sugar, will fall to the bottom of water, in which, when they are dispers'd into minute and invisible particles, they will easily float. And I have observed in stopp'd glasses, that some salts, and other bodies, that, for many months, remained undistinguish'd in the liquors that harboured them, would, in tract of time, have conventions made of their particles, which then subsided; and be no more carried up and down by the particles of the liquor. And somewhat of this kind may, perhaps, happen to the particles whereof water consists; for if some of these, by frequent occurrences and attritions, come to apply themselves to one another, so as to have a fuller and more immediate contact than formerly; to be entangled among themselves; and, perhaps, also, to exclude some very thin and subtle air, that lurks about them; and contributes to their sustentation; the clusters, tho' as to sense but very small, may prove too great and unweildy to be, any longer, parts of water, but may subside in that liquor; and if their adhesion be strong, they will, upon the same account, become unfit to rise up in the form of vapours and exhalations, by heat, and so may be, like earth, fix'd in the fire, as well as indissoluble in water.

I have sometimes, also, suspected, that the production of an earthy substance in water, may be further'd by the particles of the fire, employed to make it circulate; and that of those particles which pervade the glass, some of the less subtle may, in their passage, fasten themselves to some aqueous particles, fitted to adhere to them; and with these begin to make some invisible concretions, to which, afterwards, other congruous particles may gradually adhere in their passage; and so at length compose sensible aggregates of powder. Thus in the precipitation of quick-silver, without addition, the mercurial particles associating themselves with; and, probably, with some of those of the fire;

fire; begin to form concretions, at first very minute, which afterwards increase, by the accession of other adhering particles, till all the mercury, or the greatest part of it, be reduced, from a fluid body, to a red powder. And it may countenance this conjecture, as to the production of an earthy substance, by a brisk concurrence of the particles of fire, to add, that tho' I have kept highly rectified spirit of wine, for above a year together, hermetically seal'd up, and for the greatest part of that time, in a digestive furnace, without finding any earthy residence; yet, when I order'd a bolt-head, that, tho' it were hermetically seal'd, the alchocol of wine it contain'd, might be boil'd without breaking the glass; I found, in a short time, that this liquor would afford a considerable quantity of such a subsiding talky substance, as I obtain'd from the water formerly mention'd.

Two parts of tobacco-pipe clay, finely powder'd, and very well mix'd with one part of pulveriz'd crystals of nitre, being put into a crucible, and kept, for three hours, in a violent fire, the mixture was afterwards taken out, and the remaining fix'd salt, carefully extracted; but it amounted to a very little, in comparison of what nitre usually yields when calcined with charcoal; and, that this small proportion of fix'd salt did not, principally, proceed from any very large avolation of nitrous substance, appear'd probable, because the *Caput mortuum* was much more ponderous than could be expected upon account of the tobacco-pipe clay first employ'd, and the alkali extracted; so that the new weight, acquired by the clay, seem'd manifestly to proceed from the accession of a portion of the salt-petre, that, by this operation, was turn'd into earth; so that of six drams, which four ounces of clay had acquir'd in weight, after the crucible was taken out, not so many grains could, even by boiling water, be obtain'd from the whole *Caput mortuum*; which, when first separated from the crucible, was almost quite insipid.

That earth may, *de novo*, be produced, we may likewise argue from an experiment we made about the destruction of salt of tartar, by igniting and putting it into fair water; for there remain'd, after numerous filtrations, and after every single one, a substance in the filtre, which, for ought appears, may be as well call'd earth, as that which was separated from the calcined tartar, the first time it was put into the water, to divide the salt from the earth. For here, as well as in that common operation, the way of proceeding is the same; and in both, there remains in the filtre a substance, which, by its stay there, shows it to be indissoluble in water; and which, before it came thither, shew'd, by enduring a violent fire, that it was also fix'd, as earth ought to be. Nor would it much alter the case, if this factitious earth should have such an operation upon some particular body, as is thought not to belong to true elementary earth. For since it is obtain'd by a chymical analysis, if it have those qualities, that, in the general estimations, make up the notion of earth, that ought to suffice, at least, till the chymists



Chymistry.

mists give us some more accurate definition of genuine earth, shew us such a thing, and teach us a better way to obtain it.

And in many bodies, that are reputed earth, I observe qualities which belong not to elementary earth, in the receiv'd notion thereof. This, I say, because I see not why such a texture, as will suffice to make a portion of matter indissoluble in water, fix'd in the fire, and insipid upon the tongue, may not also fit it to operate, actively, upon some bodies; and modify the operations of others that act upon it. And if our earth, obtain'd from salt of tartar, be, by the chymists, rejected as spurious, they must confess the insufficiency of their common way of separating a true earth from the bodies they analyze; for, it seems, calcination, solution in water, and filtration, which make up their usual method, will not suffice to make our earth of tartar pass for true; tho' it appear not to be near so remote from an elementary nature, as some other bodies that are obtain'd for earth by the vulgar analysis. I have found, that the *Caput mortuum* of vitriol, remaining after it had long endured a violent fire, tho' it were diligently freed from saltiness, by repeated ablutions with hot water, was yet far from being an elementary earth; as appear'd by its deep purplish colour; its weight, far exceeding that of earth; and by an experiment that I purposely made to examine it.

And an acquaintance of mine, who dealt much in *Hungarian* vitriol, affirm'd to me, that he had out of the colcothar of a certain sort of that vitriol, not only received a considerable quantity of good copper; but separated from that copper a large portion of silver, and some grains of true gold.

No natural  
elementary  
earth.

I have not yet seen it prov'd, that nature, any more than art, affords us a true elementary earth; at least, I can say, that some, which seem to be of the more simple sort, I found, upon examination, had qualities not ascrib'd to pure earth. For, tho' tobacco-pipe clay, by reason of its fixity, whiteness, and insipidity, and its lying often deep beneath the surface of the ground, may as probably as almost any other native earth, seem elementary; yet tobacco-pipes, well bak'd, may, sometimes, be made to strike fire: and I have, more than once, try'd, that by briskly rubbing two pieces of a new tobacco-pipe one against another, they would, in a minute or two, grow warm; and being immediately smelt to, manifestly afforded a rank scent, between sulphureous and bituminous, almost like that which proceeds from pebbles and flints, when they are, likewise, rubb'd hard against one another: as if tobacco-pipe clay were not a true earth, but a fine white sand, consisting of grains, too small to be distinctly taken notice of, like those of other sand. And I found, by a hydrostatical trial, that its specific gravity was but little different from that of pebbles; its proportion in weight to water of the same bulk, being as two and a quarter to one. A tobacco-pipe may be, also, somewhat melted by a very vehement fire; for it will thereby be brought to bend.

Porcel-

Chymistry

Porcellane, or the matter whereof *China* dishes are made, is not, as some travellers have fondly imagined, a composition that requires to be buried under ground, for many years, to ripen; but, as some late authors inform us, and as I have been assured by a person who visited the place in *China*, so famous for making porcellane vessels, it is a pure sort of clay; however, I find it not to be elementary earth. For a violent fire will make it somewhat melt, and with steel it will easily strike fire, almost like a flint; whereto it approaches in specific gravity. The like I have observ'd in porcellane, very artificially imitated with a sort of *English* clay. And I found too, that the matter even of dark-colour'd jugs of the better sort, well baked, wou'd, with a steel, afford sparks of fire. But I once saw a pit, where, at the depth of many yards, they dug up a certain white earth, which when distill'd, afforded a liquor that I found to be very rich in a volatile salt, that tasted and smelt much like spirit of urine, or hartshorn; and had almost the same effects in changing the colours of some bodies, and precipitating others. I remember too, that by the operation of a menstruum or two upon tripoli, that, as white and pure a virgin earth as it seem'd, yet it prov'd not elementary. And, on the other hand, the master of some *English* mines presented me a very white substance, whereof he had plenty, which he thought an earth, and which was judg'd, by an excellent artificer very conversant with tripoli, to be finer even than that earth; but I found it, upon examination, to be a kind of talc, whose leaves were exceeding fine and minute. Hence we may reasonably doubt, whether the assertors of elementary earth can shew us any native substance deserving of that name; and, also, whether what remains, after chymical analyses, tho' it has all the qualities, judg'd sufficient to denominate a portion of matter earth, may not yet be either a compounded body, or endowed with qualities which belong not to simple earth. With this view, I purposely examined some quicklime, which, tho' it had been, by frequent ablutions in warm water, carefully dulcified, and so was as well insipid as fixed and indissoluble in water; yet I found I could readily dissolve it in several menstrua, and even in spirit of vinegar; whereas true elementary earth ought to be as well indissoluble in such liquors as in water.

THE

# THE IMPERFECTION OF THE CHYMICAL DOCTRINE OF QUALITIES.

## SECT. I.

The chymical  
theory of qua-  
lities narrow,  
defective, and  
uncertain.

**T**HE foundation of all the vulgar chymical theory seems to me precarious, and has never been demonstrated. 'Tis strange, that neither the chymists themselves, nor their adversaries, should have taken notice, that the analysis by fire, is not the only instrument of discovering the ingredients of mixt bodies; since, in several cases, this may be found by composition, as well as by resolution. Thus vitriol appears to consist of metalline parts, affociated, by coagulation, with acid ones, as well by making true vitriol with spirit of sulphur, or that of salt, as by resolving it by the fire.

And whatever chymists may be able to obtain from particular substances, it does not appear, by experience, which is the grand argument they rely on, that all mixt bodies, endowed with qualities, consist of their *tria prima*; since they have not been able, truly, and without new compositions, to resolve into those three, gold, silver, crystal, Venetian talc, &c. yet these bodies have several qualities; as the two former are fusible and malleable; and all of them have weight and fixedness: so that in these and the like bodies, whence chymists have not yet made it appear, that their salt, sulphur, and mercury can be truly and adequately separated, 'twill scarce be other than pre-



precarious, to derive the malleableness, colour, and other qualities of such bodies from those principles. *Chymistry.*

A great part of the chymical doctrine of qualities, is, also, founded on, or supposes some other things, which, as far as I know, have not yet been well proved; and I question whether they ever will be. *Supposes things not proved.*

One of their grand suppositions is, that each particular quality must have its *πρώτον δυνάμιδος*, or some peculiar material principle, to the participation of which, as of the primary, native, and genuine subject, all other bodies must owe it: but 'twill be hard to shew, what is the *πρώτον δυνάμιδος* of gravity, volatility, heat, sound, transparency, and opacity; which are qualities to be indifferently met with in bodies, whether simple or mixt.

The chymists, too, are apt to argue, that, because this or that quality, is not to be truly derived from this or that particular principle; as salt, for instance, and mercury; therefore it must needs be derivable from the third, as sulphur. But this way of arguing implies, that every quality in a compound body, must arise from some one of the *tria prima*; tho' experience shews us, that bodies may, by composition, obtain qualities, that were not to be found in any of the separate ingredients. Thus in painting, though blue and yellow be neither of them green, yet their mixture will be green. And tho' no single sound will make an octave, or *diapason*; yet two sounds, whose proportion is double, have an eighth. Tin and copper, melted and mixed together in a due proportion, make bell-metal, which is far more sonorous than either of them apart. And 'tis obvious for chymists to observe, that, tho' lead be an insipid body, and spirit of vinegar a very sharp one, yet *Saccharum Saturni*, a compound of these two, is sweet.

But this ill-grounded supposition of the chymists, is extended farther in an usual topic of theirs, according to which they conclude, that many qualities, as well manifest as occult, must be explained by their *tria prima*, because they are not explicable by the four elements of the *Peripatetics*. But to make this argument valid, it must be proved, that there are no other ways by which those qualities may be explained, but by a determinate number of material principles.

But there are several qualities, even in mixt bodies, wherein the chymical doctrine is unnecessary. For instance, when pure gold is, by bare heat, brought to the state of fluidity; and, upon the remission of that heat, grows a solid and consistent body again; what addition, expulsion, or alteration of any of the *tria prima*, causes this change of consistence? Tho' this is easily accounted for in the mechanical way, by the vehement agitation that the fire makes of the minute parts of the gold, to bring it to fusion; and the cohesion of those parts, by virtue of their gravity and fitness to adhere to one another, when that agitation ceases. When *Venice* glass is merely, by being beaten to powder, deprived of its transparency, and turned into a white, opaque body, what need have we of the *tria prima* to solve this phenomenon? *Is often superfluous.*

Chymistry.

But further; the chymical doctrine of qualities is insufficient, and too narrow to reach to all the phenomena that ought to be explicable by it. For there are many qualities, which chymists will not attempt to explain; and the solutions they give of other particular qualities, are often very deficient and unsatisfactory. Thus, tho' gold be the body they most affect to converse with; yet it will be very hard to shew, how its specific weight can be deduced from the three principles, since mercury it self is much lighter than gold; and the two other hypostatical principles are far lighter than mercury. And, I think, it would much puzzle the chymists, to give us an example of a compound body, specifically heavier than the heaviest of its ingredients.

Again; there are several bodies, which, tho' the most learned chymists confess, do not consist of their *tria prima*, yet are endowed with qualities, that consequently are not in those subjects to be explained by the *tria prima*. Thus elementary water, tho' never so pure, has fluidity, coldness, humidity, transparency, and volatility, without any of the *tria prima*. And the purest earth, as ashes carefully freed from the fixed salt, has gravity, consistence, dryness, colour, and fixedness, without owing them either to salt, sulphur, or mercury. Since, then, in earth, water, &c. such diffused qualities, as gravity, fixedness, colour, &c. must be acknowledged not to proceed from the *tria prima*; 'tis plain, that portions of matter may be endowed with such qualities, by other causes and agents than salt, sulphur, and mercury; why, therefore, should we deny, that also in compound bodies, those qualities may be produced by the same, or the like causes? Thus the reduction of a transparent solid to powder, produces whiteness, whether the comminution happens to rock-crystal, Venice glass, or to ice: the first of which is acknowledged to be a natural, and perfectly mix'd body; the second, a factitious and re-compounded body; and the last, for ought appears, an elementary body, or at most, a body very slightly and imperfectly mixt. And so by uniting air in small portions, with a transparent liquor, as when we beat such a liquor into foam, a whiteness is produced, as well in pure water, which is acknowledged to be a simple body, as in white-wine, which is reckoned among bodies perfectly mixt.

And further; the chymical explanations are not sufficiently extensive; for most of them are not so distinct and full, as to reach the particular phenomena, nor often so much as to all the grand ones, that belong to the history of the qualities they pretend to account for. A chymist will not easily shew by his salt, sulphur, and mercury, why a load-stone, capp'd with steel, may be made to take up much more iron, than if it be immediately applied to the iron; or why, if one end of the magnetic needle is dispos'd to be attracted by the north pole, for instance, of the load-stone, the other pole of the load-stone will drive it away: or, why a rod of iron, being heated red hot, and cooled perpendicularly, will, with its lower end, drive away the flower-de-luce,

of

of a mariner's needle, which the upper end of the same rod will draw to it. In short, of above threescore properties, or notable phenomena of magnetic bodies, that some writers have reckon'd up, I do not remember, that any three have been by chymists so much as attempted to be solved upon their principles. And even in those qualities, in whose explanation these principles may more probably, than elsewhere, pretend to take place, the chymical accounts are so lame and inconsistent, that they leave many considerable phenomena untouch'd; and but very slightly, and in a general way, explain the more obvious or familiar. And, indeed, I cannot but think, that a chymist, who, by the mere help of his *tria prima*, takes upon him to account for the qualities of all bodies, acts like him, who, seeing a book written in a cypher, whereof he were acquainted but with three letters, should undertake to decypher the whole piece.

And even when the chymical explanations seem to come up to the phenomena, they are not sufficiently primary and fundamental; for those very substances that chymists call their principles, are each of them endowed with several qualities. Thus salt is a consistent body, has its weight, is dissoluble in water, is either transparent or opaque, fixt or volatile, sapid or insipid. And sulphur, according to the chymists, is a body fusible, inflammable, &c. and, according to experience, consistent, heavy, &c. so that 'tis by the help of more primary and general principles, that we must explain some of those qualities, which being found in bodies, supposed perfectly similar, cannot be pretended to be derived into one of them from the other. And to say, that 'tis the nature of a principle to have this or that quality, as, for instance, of sulphur to be fusible, and therefore we are not to exact a reason why it is so; will be of no force, if from the primary properties of bodies, we may deduce any good mechanical explication of fusibility in the general, without necessarily supposing such a primogeneal sulphur, as the chymists fancy, or deriving it from thence in other bodies. And, indeed, since not only salt-petre, sea-salt, vitriol, and alum, but salt of tartar, and the volatile salt of urine, are all of them fusible; I do not well see, how chymists can derive the fusibility even of salts obtained by their own analysis, from the participation of the sulphureous ingredient; especially since, if such an attempt should be made, it would overthrow the hypothesis of three simple bodies, whereof they will have all mixt ones to be compounded: and still 'twould remain to be explained, upon what account the principle, that is said to endow the other with such a quality, comes to be itself endowed therewith. For 'tis plain, that a mass of sulphur is not an atomical, or adamantine body; but consists of a multitude of corpuscles of determinate figures, connected after a determinate manner; so that it may be reasonably demanded, why such a convention of particles, rather than any other, constitutes a fusible body.



And when they tell us, that the fusibility of bodies proceeds from sulphur, in case they say true, they only tell us what material ingredient 'tis, that being dispers'd through the other parts of a body, makes it apt to melt: but this does not intelligibly shew what it is that makes a portion of matter fusible; and how the sulphureous ingredient introduces that disposition into the rest of the mass wherewith 'tis united: yet they are such explanations as these, that a philosopher chiefly looks after. And to shew, that there may be more fundamental explanations, I shall only observe, that sulphur it self is fusible; and therefore, as I lately intimated, fusibility, which is not the quality of a single atome, or particle, but of an aggregate of particles, ought it self to be accounted for in that principle, before the fusibility of all other bodies be derived from it. And in sulphur it self, that quality may be probably deduced from the convention of corpuscles of determinate shapes and sizes, connected after a particular manner. And if nature, art, or chance, should bring together particles endowed with the like mechanical properties, and associate them after the like manner, the resulting body would be fusible, though the component particles had never been parts of the chymists primordial sulphur: and such particles so convening, might perhaps have made sulphur, though before there had been no such body in the world. And though I readily allow, that sulphur, or another of the *tria prima*, may abound in several bodies endowed with the quality that is attributed to their participation of that principle; yet this is no certain sign, that the propos'd quality must flow from that ingredient. Thus, if tin, for example, be duly mix'd with copper or gold, silver or iron, it will make them very brittle; and it is also an ingredient of several other bodies that are likewise brittle; as colour'd amels, which are usually made of calcin'd tin, (call'd by tradesmen putty,) melted with the ingredients of crystal-glass, and some small portion of a mineral pigment. But though in all these brittle bodies, tin be a considerable ingredient; yet 'twere very rash to affirm, that brittleness, in general, proceeds from tin: for provided the solid parts of consistent bodies touch one another but in small portions of their surfaces, and be not entangled by their contexture, the metalline or other composition may be brittle, tho' there be no tin at all in it: and, in effect, the materials of glass being brought to fusion, will compose a brittle body, as well when there is no putty colligated with them, as when there is. Calcin'd lead, by the action of the fire, may be melted into a brittle mass, and even into transparent glass, without the help of tin, or any thing else. And there are numerous other bodies, that cannot be pretended to owe their brittleness to any participation of tin, of which they have no need, if the matter they consist of, wants not the requisite mechanical dispositions.

And the way employed by chymists, and *Peripatetics*, of accounting for things from the materials, whether elements, principles, or other ingre-

ingredients, of bodies, will often frustrate this expectation; for a new quality, differing from, or contrary to, any that is conspicuous in the ingredients, will frequently arise upon their mixture; as two transparent bodies may make an opaque one; a yellow body and a blue, one that is green; two malleable bodies, a brittle one; two actually cold bodies, a hot one; two fluid bodies, a consistent one, &c. And as this way of judging, by material principles, hinders the fore-knowledge of events from being certain, it much more hinders the assignation of causes from being satisfactory; so that those who judge of all mix'd bodies, as apothecaries do of medicines, barely by the qualities and proportions of the ingredients, seem to act as one who should pretend to give an account of the phenomena and operations of clocks and watches, from the predominancy of the metals that make their parts, and not from their structure and contrivance.

The next defect I observe in the chymical doctrine of qualities, is, that in many cases it agrees not with the phenomena of nature. For there are several changes of qualities, wherein one may well expect, that a chymical principle should have a great share, and yet it does not appear to have any. He who considers what great operations many chymists ascribe to this or that hypostatical principle, and how many qualities, according to them, must from thence be derived, cannot but expect, that a great change, as to those qualities, happening in a mix'd body, should, at least, be accompany'd with some notable action of, or alteration in the principle; yet I have met with many instances, wherein qualities are produced, or abolished, or very much altered, without any manifest introduction, expulsion, or considerable change of the principle, whereon that quality is said to depend. Thus, for instance, a piece of fine silver, having been heat'd in the fire, and suffer'd to cool leisurely, is very flexible; but may be made stiff and hard, barely by a few strokes of a hammer. There is, also, another sort of phenomena, which opposes the chymical doctrine about qualities, consisting of those, wherein either that does not happen, which, according to their hypothesis, ought to happen, or the contrary to what, upon their principles, might justly be expected. For instance, 'tis known to those who work much in silver and copper, that the former will become red-hot in the fire, before it is brought to fusion; and that the latter is yet far more difficult to be melted down than the other; yet if you separately dissolve those two metals in *Aqua fortis*, and by evaporation, reduce them to crystals; these will be brought to fuse in a very little time, and with a moderate heat in glasses. Ask a vulgar chymist, the cause of this facility of fusion, and he will probably tell you, that 'tis from the saline parts of the *Aqua fortis*, which, imbody'd in the metals, and being of a very fusible nature, impart that easiness of fusion thereto. Now from this plausible explanation one might well expect, that if the saline corpuscles were exquisitely mixed with tin, they would make it far more fusible than of itself it is; yet when I put tin into a

And frequently contradicts the phenomena of nature.

*Chymistry.* convenient quantity of *Aqua fortis*, the metal being corroded, subfided, as is usual, in the form of whites of eggs, which being well dried, the tin was so far from growing more fusible, that it would long endure not only a thorow ignition, but the blast of a pair of double bellows, without being at all brought to melt. And as for those chymists who admit, that all kinds of metals may be turned into gold, by a very small proportion of the elixir; they must allow from their own concessions, that several qualities may be changed, even in metals, without the addition of any considerable proportion of the simple ingredients, to which they ascribe those qualities; provided the agent be able to make a great change in the mechanical properties of the parts whereof the metal it acts upon consists. Thus if we suppose a pound of silver, a pound of lead, and a pound of iron, to be transmuted into gold, each by a grain of the powder of projection; this powder, as a material cause, is inconsiderable, by the smallness of its bulk; and as an efficient, it works differing, and even contrary effects, according to the disposition wherein it finds the metal to be transmuted, and the changes it produces in the constituent texture thereof. Thus it brings quick-silver to be fixt, and deprives it of the fluidity it had before; it brings silver to be insoluble in *Aqua fortis*, which readily dissolved it before, and soluble in *Aqua regis*, which before would not touch it; and, what is very considerable to our present purpose, whereas it makes iron much more fusible, it makes lead much less fusible than whilst it retained its pristine form; since lead melts before it comes to ignition, which gold requires to bring it to fusion.

But some modern chymists would be thought to explain several of the changes that happen to bodies in point of odour, colour, &c. by saying, that in such alterations the sulphur, or other hypostatical principle, is intraverted or extraverted; which, I confess, seem to me rather new terms, than real explanations. For it may be justly objected, that the supposed extraversion or intraversion of sulphur can, by no means, give an account of so great a variety of odours, colours, and other qualities, as may be found in the changed portions of matter we are speaking of. Besides, what they call by these and the like names, cannot be done without local motion, transposing the particles of the matter, and, consequently, producing in it a change of texture, which is the very thing we would infer; and which being supposed, we may grant sulphur to be often actually present in the altered bodies, without allowing it to be always necessary to produce the alterations in them; since corpuscles, so condition'd and arranged, would produce such effects, whether sulphur did, or did not, make the subject-matter of the change.

I shall mention but two imperfections more that particularly relate to the doctrine of qualities.

And first I do not think it a convincing argument, that is employed by the *Aristotelians* for their elements, and by the chymists for their

*The principles found in bodies not the cause of their qualities.*



their principles, that, because this or that quality, which they ascribe to an element, or a principle, is found in this or that body, which they call mixt, therefore it must owe that quality to the participation of that principle or element. For, the same texture of parts, or other modification of matter, may produce the like quality in the more simple and the more compound body; and they may both, separately, derive it from the same cause, and not one from the participation of the other. Thus water, earth, metals, stones, &c. are heavy upon account of the common cause of gravity, and not because the rest partake of earth; for elementary water, as simple a body as that, is yet heavy: so oil, highly rectified spirit of wine, mercury, metals, glass of antimony, and minium, whilst in fusion, are fluid; being made so by the variously determined motions of their minute parts, and other causes of fluidity; and not by the participation of water; since the dry calces of lead and antimony are not likely to have retained in the fire so volatile a liquor as water; and since fluidity is a quality that mercury enjoys in a more durable manner than water it self: for that metalline liquor, as also spirit of wine well rectified, will not be brought to freeze with the highest degree of cold of our sharpest winters, tho' a far less degree of cold would make water cease to be fluid, and turn it to ice.

And lastly, 'tis pleasant to see how arbitrarily the *Peripatetics* derive the qualities of bodies from the four elements. Thus to instance in liquidity, if you shew them exactly dephlegmed spirit of wine, and ask, whence it has its great fluidity, they will tell you, from water; which yet is far less fluid than it; and spirit of wine it self is much less so than the flame into which that spirit is easily excited. But if you ask, whence it becomes totally inflammable, they must tell you, from the fire; and yet the whole body, at least as far as sense can discover, is fluid, and becomes flame; so that fire and water, as contrary as they make them, must both be vastly predominant in the same body. This spirit of wine, also, being a liquor, whose least sensible parts are actually heavy, and compose a liquor seven or eight hundred times as heavy as air of the same bulk, must be supposed to abound with earthy particles; and yet this spirituous liquor may, in a trice, become flame, which they would have to be the lightest body in the world.

Contrary qualities ascribed to the same body.

Upon the whole, the chymist's salt, sulphur, and mercury themselves, are not the first and most simple principles of bodies, but rather primary concretions of corpuscles or particles more simple than they; as being endowed only with the first most radical, and most universal properties of simple bodies, bulk, shape, motion, or rest; by the different conventions or coalitions of which minutest portions of matter, are made those differing concretions that chymists call their principles.

## S E C T. II.

Reflections  
upon the hypo-  
thesis of alkali  
and acid.

I Presume, it will not be difficult to discern, that a great part of what has been alledg'd to shew the imperfection of the vulgar chymical doctrine of qualities, may easily be applied to some other hypotheses of kin to that doctrine, and particularly to the theory that would derive both the qualities of bodies, and the rest of the phenomena of nature, from acid and alkali. For tho' these two differences may be met with in a great variety of bodies, and consequently the consideration of them will frequently be of good use to chymists, in considering the secondary causes and operations of some mixt bodies; yet I cannot allow of the hypothesis in the latitude wherein 'tis urged and applied, as if it could be usefully substituted in the place of matter and motion\*.

The suppo-  
sition of them  
precarious.

For it seems precarious to affirm, that acid and alkaline parts are found in all bodies.

Some chymists, when they see *Aqua fortis* dissolve filings of copper, conclude from thence, that the acid spirits of the menstruum meet, in the metal, with an alkali, upon which they work; † but this is an un-

\* "Since," says M. Homberg, "the doctrine of alkali and acid has been advanced, 'tis made use of to explain all the changes that happen in the mixtures of simples, particularly in the effects of fermentation, effervescence, and ebullition. But there is scarce any fermentation produced by the mixture of acid and alkali; and even ebullitions and effervescences often pro-

ceed from other causes." See French *Memoirs*, A. 1701. p. 146.

† M. Homberg is of opinion, that all acid spirits dissolve bodies, by means of the salt which such spirits contain; and to discover their quantity of pure acid salts, he suffers an ounce of salt of tartar to saturate it self with the spirit; then evaporating all the moisture, the salt of tartar remains increased by the weight of the acid salts.

By this means he made the following table.

|                               | oz. | dr. | gr. |           | dr. | gr. |                 | dr. | gr. |
|-------------------------------|-----|-----|-----|-----------|-----|-----|-----------------|-----|-----|
| An ounce of Spirit of nitre   | 01  | 02  | 36  | And gain- | 03  | 10  | Whence an       | 02  | 28  |
| — of salt                     | 02  | 05  | 00  | ed after  | 03  | 14  | ounce of the    | 01  | 15  |
| Oil of vitriol                | 00  | 05  | 00  | evapora-  | 03  | 05  | liquor con-     | 04  | 65  |
| took up of <i>Aqua fortis</i> | 01  | 02  | 30  | tion      | 03  | 06  | tain'd of vola- | 02  | 26  |
| Distill'd vinegar             | 14  | 00  | 00  |           | 03  | 36  | tile acid salt  | 00  | 18  |

He, likewise, uses an instrument, or areometer, made of a small glass matras, with a neck, AD, so slender, that a single drop of water will rise about half an inch in it. On the side of this neck there comes from the belly B, of the vessel, a small tube C, of the same size with the neck, and paral-

lel to it, above half an inch long. This little tube lets the air pass out of the vessel, as the liquor comes in. A mark D, is put upon the neck AD, to shew how high the vessel must be filled. And 'tis proper to let the neck widen towards the top, for the conveniency of pouring

unsafe way of arguing, since good spirit of urine, which they take to be a volatile alkali, and which makes a great conflict with *Aqua fortis*, will readily dissolve filings of copper, and more genuinely than the acid liquor. So when they see the magistery of pearl or coral, prepared by dropping oil of tartar into the solutions of those bodies, made with spirit of vinegar, they ascribe the precipitation to the fixt alkali of the tartar, that mortifies the acidity of the spirit of vinegar; whereas the precipitation would no less ensue, if, instead of the alkalizate oil of tartar, that strong acid, *Oleum sulphuris per campanam*, were employ'd.

in the liquor. Now this instrument being fill'd to the mark on its neck, with any acid spirit, the balance will shew the weight of the liquor, in respect of any other, to the fifth part of a drop. Hence

this ingenious gentleman has made a table, to shew the different weights of the same bulk of the most considerable chymical liquors, in the summer and in winter.

| The Aræometer full of ————— | Weigh'd in summer. |     |     | In winter. |     |     |
|-----------------------------|--------------------|-----|-----|------------|-----|-----|
|                             | oz.                | dr. | gr. | oz.        | dr. | gr. |
| Quick-silver —————          | 11                 | 00  | 07  | 11         | 00  | 32  |
| Oil of tartar —————         | 01                 | 03  | 08  | 01         | 03  | 31  |
| Spirit of urine —————       | 01                 | 00  | 32  | 01         | 00  | 43  |
| Oil of vitriol —————        | 01                 | 03  | 58  | 01         | 04  | 03  |
| Spirit of nitre —————       | 01                 | 01  | 40  | 01         | 01  | 70  |
| — of salt —————             | 01                 | 00  | 39  | 01         | 00  | 47  |
| <i>Aqua fortis</i> —————    | 01                 | 01  | 38  | 01         | 01  | 55  |
| Distill'd vinegar —————     | 00                 | 07  | 55  | 00         | 07  | 60  |
| Spirit of wine —————        | 00                 | 06  | 47  | 00         | 06  | 61  |
| River-water —————           | 00                 | 07  | 53  | 00         | 07  | 57  |
| Distill'd water —————       | 00                 | 07  | 50  | 00         | 07  | 54  |

The instrument it self weighed, when empty, one dram twenty-eight grains.

From these two tables, compared together, 'tis easy to determine, with great exactness, the quantity of salt and of phlegm contain'd in an acid spirit. See *Memoirs de l'Acad. A. 1669. p. 69.*

To measure the force of an alkali, that is, to estimate how much of an acid 'tis able to retain, the same gentleman proceeds in this manner. He dissolves the alkali in some acid spirit, whose force is first discovered by means of his aræometer; comparing its weight with that of river-water. Thus having dephlegmed some spirit of nitre, and of salt, till the former perfectly dissolved gold, and the latter silver, he found the weight of the spirit of nitre to be, in an equal bulk, as 19, that of the spirit of salt as 17, and that of water as 16. He put an ounce of each spirit upon crabs-

V O L. III.

eyes, coral, pearl, bezoar, oyster-shells, &c. of which they dissolved different quantities; the spirit of nitre taking up twice as much of some of them as the spirit of salt; and in general, the former dissolved a considerable quantity more than the latter; the proportion of its salt being almost double to that of the other. Now the different quantity of each alkali necessary to absorb the same quantity of a standard acid, is, according to M. *Hornberg*, the measure of the passive force of that alkali; notice being taken of the time spent in the dissolution. This author farther observed, that both the spirits readily dissolved much more of the oyster-shells than of any other powder of the like nature; which he takes to be one reason of the very good effect they have in the stomach, depraved by acids. *Memoir de l'Acad. A. 1700. p. 81. and Hist. de l'Acad. A. 1700. p. 63.*

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Chymistry.

It also may be doubted, whether the vulgar chymists justly suppose, that when they manifestly discover an acid, for instance, in a body, the operation of that body upon another, which they judge to abound with an alkali, must be the effect of a conflict between those two principles. For an acid body may do many things, not simply as an acid, but on account of a texture or modification, which endows it with other qualities as well as acidity. Thus when some chymists see an acid menstruum, as *Aqua fortis*, spirit of salt, oil of vitriol, &c. dissolve iron, they presently ascribe the effect to an acidity in the liquors; tho' well dephlegmed urinous spirits, which they hold to have a great antipathy to acids, will, as I have tried in some of them, readily dissolve crude iron, even in the cold. But mercury will not work on the filings of iron, tho' this be so open a metal, that even weak liquors will do it; yet if one should urge, that quick-silver readily dissolves gold in amalgamation, he may expect to be told, according to their doctrine, that mercury has in it an occult acid, by which it performs the solution; tho' it seems much more probable, that mercury has corpuscles of such a shape and size as fit them to insinuate into the correspondent pores they meet with in gold, but render them unfit to enter readily the pores of iron, to which nature has not made them suitable: as on the other side, the saline corpuscles of *Aqua fortis* will easily find admission into the pores of iron, but not into those of gold, to which they do not correspond. And when a knife, whose blade is touched with a load-stone, cuts bread, and takes up filings of iron, it does neither by means of alkali or acid; but the one by the visible shape and the stiffness of the blade, and the other by the latent contrivance or change of texture, produced by the operation of the load-stone in the particles of the steel.

And thus too, when blue vitriol, being beaten and finely searced, makes a white powder, that whiteness is not a quality of the powder, as being of a vitriolate nature; for rock-crysal, or *Venice* glass, finely beaten, will have the same effect on the eye; but it proceeds from the transparency of the body, and the minuteness, multitude and confus'd situation of the corpuscles that make up the powder. And, therefore, if other bodies be brought, by comminution, into parts of the like mechanical properties; these aggregates will act upon the organ of sight as white bodies.

Their offices  
arbitrary.

Further, the patrons of this hypothesis seem arbitrarily to have assigned offices to each of their two principles, as the chymists do to each of their *tria prima*, and the *Peripatetics* to each of their four elements. But 'tis not enough to say, that an acid, for instance, performs these things, and an alkali those; and that they divide the operations and phenomena of natural bodies between them: assertions of such great moment ought not to be advanced, or received, without sufficient proof. And, perhaps, the very distribution of salts into acids and alkalies hath somewhat of arbitrary in it; since others may, without

out assuming much more, take the freedom to distribute them otherwise; there being not only several things wherein acids and alkalies agree, but also several things wherein salts of the same denomination widely differ. For instance, some alkalies, according to our chymists, are, like salt of tartar, fixt, and will endure the violence of the fire; others, like salt of urine or hartshorn, are exceedingly fugitive, and will be driven up with a scarce sensible degree of heat; some, as salt of tartar, will precipitate the solution of sublimate into an orange-tawny; others, as spirit of blood and hartshorn, precipitate such a solution into a milky substance; and oil of tartar very slowly operates upon filings of copper, which spirit of urine and hartshorn will readily dissolve in the fire.

And among acids themselves the difference is no less; for some of them will dissolve bodies that others will not, as *Aqua fortis* dissolves silver and mercury, but leaves gold untouch'd; *Aqua regis*, that dissolves gold readily, dissolves mercury but imperfectly, and silver not at all. And this may happen, when the menstruum, that will not dissolve the body, is reputed much stronger than that which does; as dephlegm'd spirit of vinegar will dissolve lead, reduc'd to minute parts, in the cold; which is an effect that chymists expect not from spirit of salt. Nay, one acid will precipitate what another has dissolved, and *à contrà*; as spirit of salt will precipitate silver out of spirit of nitre. And I found oil of vitriol to precipitate bodies of various kinds, minerals, and others, out of some acid menstrea, particularly spirit of vinegar.

We might add the properties peculiar to some particular acids, as that spirit of nitre, or *Aqua fortis*, will dissolve camphire into an oil, and coagulate common oil into a consistent and brittle substance, like tallow; and tho' it will both corrode silver, copper, lead, and mercury, and keep them dissolved, it quickly lets fall almost the whole body of tin, very soon after having corroded as much as it can thereof. Hence we may very well question, whether acid and alkali have the simplicity that philosophy requires in principles. Nor will it be any wonder if others shall think it as free for them to constitute other principles, as 'tis for chymists to pitch upon acid and alkali.

And some, perhaps, will say, that, since the former of these principles comprehends such a number of very different bodies, it seems as slight and unphilosophical an account of their nature, to define an acid by its hostility to an alkali, as to define a man by saying, that he is an animal at enmity with the serpent.

But tho' one of the chief conditions that philosophers justly require in principles, is, that they should be very clear; yet I do not wonder, that the definitions given us of acid and alkali should be inaccurate and superficial; since I find not, that chymists themselves have any clear and determinate notion or sure marks, whereby to know them distinctly. For to infer, as is usual, that, because a body

And the notion of them unsettled.

Chymistry.

dissolves another, which is dissoluble by this or that known acid, the solvent must also be acid; or to conclude, that if a body precipitates a dissolved metal out of a confessedly acid menstruum, the precipitant must be an alkali, is precarious; since filings of spelter will be dissolved as well by some alkalies, viz. spirit of sal-armoniac, &c. as by acids: and bodies may be precipitated out of acid menstrea, by other acids, and by liquors wherein there appears not the least alkali. I have found, that a solution of tin-glass, made in *Aqua fortis*, would be precipitated both by spirit of salt, and by common or rain-water. And as for the other grand way that chymists employ, to distinguish acids and alkalies, by the heat, commotion, and bubbles that are excited, upon their being put together; this may be no such certain sign as they presume: for almost any thing that is fitted variously and vehemently to agitate the minute parts of a body, will produce heat in it; and so, tho' water be neither an acid nor an alkalizate liquor, yet it will quickly grow very hot, not only with the highly acid oil of vitriol, but with the alkalizate salt of tartar: yet in neither of these mixtures is there produced any such visible or audible conflict, as, according to the doctrine of the chymists, one would expect. Neither is the production of bubbles, tho' accompanied with a hissing noise, such a certain sign as chymists imagine: for the production of bubbles is not a necessary effect or concomitant of heat, excited by conflict; but depends very much upon the peculiar disposition of bodies, put together, to extricate, produce, or intercept particles of air; and therefore, as oil of vitriol, mixt in a due proportion with fair water, may be brought to make the water very hot, without exciting bubbles; so I have found that alkalizate spirit of urine, drawn with some kinds of quick-lime, being mixt with oil of vitriol moderately strong, would afford an intense heat, whilst it produced either no manifest bubbles at all, or scarce any; tho' the urinous spirit was strong, and in other trials operated like an alkali; and tho' with spirit of urine, made *per se*, in the common way, oil of vitriol will produce a great hissing, and a multitude of conspicuous bubbles. On the other side, I have, sometimes, found, that some acid spirits, especially that of verdigrease, made *per se*, would, when poured upon salt of tartar, make a conflict with it, and produce a large froth; tho' we observed it not to be accompanied with any manifest heat.

The taste no  
judge of alkali  
and acids.

The taste, by many, is made the touch-stone whereby to try acids and alkalies. But there is a multitude of mixt bodies, wherein we can so little discern by the taste, which of the principles is predominant, that this would not make one suspect there were a grain of either of them to be found therein; such bodies are diamonds, rubies, and most gems, besides many ignobler stones, gold, silver, mercury, &c. There are also bodies that abound with acid or alkalizate salts, which either have no taste, or a quite different one from that of the chym-



chymical principles. Thus, tho' *Venice* glass be in great part composed of a fixt alkali; yet it is insipid upon the palat: and crystals of silver, and of lead, made with *Aqua fortis*, and containing numerous acid particles of the menstruum, manifest nothing of acidity in the mouth; the latter having a saccharine sweetness, and the former an extreme bitterness. And even in vegetable substances of a manifest tast, 'tis not easy to know by that, whether it be the acid or the alkalizate principle which rules in them; as in the essential oils of spices and other vegetables, and in the gross empyreumatical oils of woods, and even in high rectified spirit of wine, which, therefore, some will have to be an alkalizate liquor, and others an acid, tho' I did not find its tast to be destroyed or much altered by being put upon coral or salt of tartar, nor by being digested with and distill'd from sea-salt. And among those very bodies which, for their tastes, chymists reckon among acids, there is so great a difference and variety of relishes, that, if I were to allow acids to be one principle, it should be as I allow air to be one body, whilst it consists of the associated effluvia of a multitude of corpuscles of very differing natures. \*

Ano-

\* At once to establish a just notion, to explain the nature, the manner of action, and the force of acids, take the words of the illustrious Sir *Isaac Newton* upon the subject.

"The particles of acids," says that great philosopher, "are of a size grosser than those of water, and therefore less volatile; but much smaller than those of earth, and therefore much less fix'd than they. They are endued with a great attractive force; in which force their activity consists; and thereby also they affect and stimulate the organ of tast, and dissolve such bodies as they come at. They are of a middle nature between water and terrestrial bodies, and attract the particles of both. By this attractive force they get about the particles of bodies, whether they be of a metalline or stony nature, and adhere to them most closely on all sides; so that they can scarce be separated from them by distillation, or sublimation. When they are attracted and gathered together about the particles of bodies, they raise, disjoin, and shake them one from another; that is, they dissolve those bodies. By their attractive force, also, by which they rush towards the particles of bodies, they move the fluid, excite heat, and

"shake asunder some particles, so as to turn them into air, and generate bubbles; and hence proceeds dissolution, and all violent fermentation: and in all fermentation there is an acid latent or suppress'd, which coagulates in precipitation. Acids, also, by attracting water, as much as they do the particles of bodies, occasion the dissolved particles readily to mix with water, or swim, or float in it, after the manner of salts. And as this globe of earth, by the force of gravity, attracting water more strongly than lighter bodies, causes those lighter bodies to ascend in the water, and to go upwards from the earth; so the particles of salts, by attracting the water, mutually avoid, and recede from one another as far as they can, and thence are diffus'd throughout the whole water. The particles of *Sal alkali* consist of earth and acid united together, after the same manner: but these acids have so great an attractive force, that they can't be separated from the salts by fire. They also precipitate the particles of metals dissolv'd in menstrua, by attracting from them the acid particles, which before had dissolved them, and kept them suspended in the menstruum. If these acid particles be join'd with earthy

Chymistry.

Another particular wherewith I am unsatisfied in the hypothesis of acid and alkali, is, that 'tis in many cases needless to explain the

“ earthy ones, in a small quantity,  
 “ they are so closely retained by them,  
 “ as to be quite suppress'd, and, as it  
 “ were, hidden by them; so that they  
 “ neither stimulate the organ of sense,  
 “ nor attract water, but compose bodies  
 “ which are not acid, that is, fat and fu-  
 “ sible bodies, such as are *Mercurius dulcis*,  
 “ brimstone, *Luna cornea*, and copper cor-  
 “ roded by mercury sublimate. From  
 “ the attractive force in these acid par-  
 “ ticles thus suppress'd, arises that uni-  
 “ versal property of almost all fat bodies,  
 “ that they adhere or stick to others, and  
 “ are easily inflammable, if the heated  
 “ acid particles meet with other particles  
 “ of bodies in fume, which the acid  
 “ attracts more strongly, than it doth the  
 “ particles to which it is united. And  
 “ thus the acid that lies suppress'd in  
 “ sulphureous bodies, by more strongly  
 “ attracting the particles of other bodies  
 “ (earthy ones for instance) than its own,  
 “ promotes a gentle fermentation, pro-  
 “ duces and cherishes natural heat,  
 “ and carries it on sometimes, as  
 “ the putrefaction of the compound:  
 “ which putrefaction arises hence, that  
 “ the acid particles, which have a long  
 “ while kept up the fermentation, at  
 “ length insinuate themselves into the  
 “ little interstices, that lie between the  
 “ particles of the first composition; and  
 “ so, intimately uniting with those very  
 “ particles, produce a new mixture or  
 “ compound, which cannot fall back  
 “ again into the same form.

“ Nitre in distillation, leaving its earthy  
 “ part behind, turns, most of it, into an  
 “ acid spirit; because the acid of the  
 “ nitre attracts the phlegm, and, there-  
 “ fore, they ascend together, and consti-  
 “ tute a spirit. But nitre kindled with  
 “ a coal, turns chiefly into a salt of tar-  
 “ tar; because the fire apply'd this way,  
 “ drives the acid and earthy parts to-  
 “ gether, and makes them impinge on,  
 “ and more strongly unite one with ano-  
 “ ther. The reason why water hath no  
 “ great dissolving force, is, because there  
 “ is but a small quantity of acid in it:  
 “ for whatever strongly attracts, and is

“ strongly attracted, may be called an  
 “ acid; and in such things as are dissolv'd  
 “ in water, we see the dissolution is easily  
 “ perform'd, and without any effe-  
 “ vescence: but where the attraction is  
 “ strong, and the particles of the men-  
 “ struum are every way attracted by  
 “ those of the metal; or rather, where  
 “ the particles of the metal are every  
 “ way attracted by those of the men-  
 “ struum; there the particles of the  
 “ menstruum environ those of the  
 “ metal, tear them asunder, and dissolve  
 “ its texture. So when these acid par-  
 “ ticles are applied to the tongue, or to  
 “ any excoriated part of the body; leaving  
 “ the subtiler earth in which they were  
 “ before, they rush into the liquid of  
 “ the organ, tear and disjoin its parts,  
 “ and cause a painful sensation.

“ Mercury is attracted, and, therefore,  
 “ corroded by acids; and as it opens  
 “ obstructions by its great weight, so it  
 “ breaks and obtunds the power of acids,  
 “ in the body, by its attractive force.

“ All bodies have particles which mu-  
 “ tually attract one another; the aggre-  
 “ gates of the least of which may be  
 “ called particles of the first composition;  
 “ and the collections, or aggregates,  
 “ arising from the primary aggregates,  
 “ or the aggregates of these aggregates  
 “ may be called particles of the second  
 “ composition, &c.

“ Mercury and *Aqua regia*, pervade  
 “ those pores of gold or tin, which lie  
 “ between the particles of its last com-  
 “ position; but they can get no further  
 “ into it; for if any menstruum could  
 “ do that, or if the particles of the first,  
 “ or, perhaps, of the second composition  
 “ of gold, could be separated, that metal  
 “ might be made fluid, or at least  
 “ more soft. And if gold could be  
 “ once brought to ferment and putre-  
 “ fie, it might be turned into any  
 “ other body whatsoever; and so of  
 “ tin, or any other bodies; as com-  
 “ mon nourishment is turned into the  
 “ bodies of animals and vegetables.”

Newton. *apud Harris. Lexicon Technic.*

phenomena of qualities; several of these being produced, destroyed, *Chymistry.* or altered, where there does not appear any access, recess, or change of either of those two principles; as when fluid water, by beating, is turn'd into consistent froth; and when transparent red coral is, barely by grinding, changed into a white and opaque powder.

*The hypothesis of them often needless and insufficient.*

Besides, the patrons of acid and alkali, tho' they would seem to constitute but two principles, are obliged to make many different sorts of acids, and some variety of alkalies; and still their principles are too scanty to afford any satisfactory explanation of phenomena. 'Twill be very difficult for them to give a rational account of gravity, elasticity, light, colours, sounds, and some other qualities that are called manifest; and much more of several that are confessedly occult, as electricity, and magnetism: and this shews a great insufficiency in the hypothesis.

The last defect I shall mention in the doctrine of alkali and acid is, that most of those very things which are pretended to be explained by it, are not satisfactorily explained.

*Affording but unsatisfactory solutions of phenomena.*

I am dissatisfied with the very fundamental notion of this hypothesis, a supposed hostility between the tribe of acids and that of alkalies: for I look upon amity and enmity as affections of intelligent Beings; and I have not yet found it explained by any, how those appetites can be placed in bodies inanimate, and destitute of knowledge and sense. And what is called sympathy and antipathy between such bodies, in great measure depends upon the action of our own understanding, which, supposing in every body an innate appetite to preserve it self, both in a defensive and an offensive way, inclines us to conclude, that a body, which destroys, or impairs, the state or texture of another, has an enmity to it; tho', perhaps, a slight mechanical change may make bodies, that seem extremely hostile, appear to agree very well, and co-operate to the production of the same effects. Thus, if the acid spirit of salt, and the volatile alkali, commonly called spirit of urine, be put together, they will, after a fierce conflict, unite together upon a new contexture, into a salt, little differing from sal-armoniac; in which the two reconciled principles amicably join in cooling water, dissolving some metalline bodies, and producing several other effects. And so, if upon a strong solution of salt of pot-ashes, or of salt of tartar, good spirit of nitre be dropt in a due proportion; after the heat, tumult, and ebullition are over, the acid and the alkalizate salts will convene into such a concretion as salt-petre; which is taken to be a natural body, either homogeneous, or at least consisting of parts that agree very friendly together, and conspire to constitute the particular kind of salt that chymists call nitre.

Again;



*Chymistry.*

Again; the explanations given of phenomena, according to the doctrine of alkali and acid, do not perform what may be justly expected from philosophical solutions. 'Tis said, indeed, that the acid working on the alkali, or this upon that, produces the effect proposed; but this is only to tell us, what is the agent that operates, and not the manner of the operation, or the means and process whereby it produces the effect. And if it be said, that it is by the mutual hostility of the principles, that the effect is produced, it may be answered, that this hostility it self is not, as we have just now observed, a thing clear, if so much as intelligible; and were it, yet so general and indeterminate a way of explaining things, can afford little or no satisfaction to one who considers how very numerous and various the phenomena of qualities are.

To clear and confirm this assertion, I shall only take notice of some few obvious phenomena of one of the most familiar operations, wherein acid and alkali are supposed to be the grand agents. 'Tis a known thing, that *Aqua regis* will dissolve gold, copper, and mercury; and that with these metals, especially with the second, it will produce an intense degree of heat. If now the cause of this heat be demanded, it may be expected, that the patrons of acid and alkali will answer, that 'tis from the action of the acid salts of the menstruum upon the alkali they meet with in the metals. But it is easy to discern, that this answer names, indeed, two supposed efficient causes of heat, but does not declare how these agents produce that quality; which depends upon a certain, vehement, and various agitation of the insensible parts of bodies. And, therefore, gold and copper, by bare concussion, may be brought to an intense degree of heat, without the accession of any acid particles to work upon them. But, further, when I am told, that *Aqua regis*, by its acidity working on the metal-line alkali, makes a dissolution of the metal; I am told, indeed, what they think to be the agent in this change, but not at all satisfied how this agent effects it; for, copper being a very hard metal, and gold generally esteemed, by chymists, the closest and compactest body in nature, I would gladly know, by what power such weak, and, probably, brittle or flexible bodies, as acid salts, are enabled with that force to disjoin such solid, and closely coherent corpuscles, as make up the visible masses of copper and gold; and shatter them with that violence, as, perhaps, to toss up multitudes of them into the air. And since in the dissolution of these metals, there is another phenomenon to be accounted for, as well as the forcing of the parts asunder; the sustentation of the metal in the menstruum; the chymists would greatly inform me, by well explaining how their acid and alkali are able to sustain, and give fluidity to the corpuscles of the dissolved metal; which, tho' it be but copper, is nine times as heavy

heavy as an equal bulk of water; and if it be gold, is nineteen times heavier than the liquor that must sustain it; and, at least, several times heavier *in specie* than the salts that are mixed with the aqueous parts, can make the menstruum composed of them both: at the same time, experience has assured me, that if a piece of wax, or any like matter, be made less than the hundredth part heavier than an equal bulk of water, it will, when thoroughly immersed, fall to the bottom, and rest there. I might further ask, why, as *Aqua regis* dissolves mercury, without being much changed in colour by it, gold retains its own yellowness in the solvent; and why the solution of copper is of a colour quite different from that of the metal which affords it, and from that of the solvent? In short, those hypotheses greatly hinder the progress of human knowledge, that introduce morals and politics into philosophy, where all things are transacted according to mechanical laws.

Chymistry.







## The P R E F A C E.

**W**E have now traced Mr. Boyle to the last stage of his philosophical works, that of medicine. And, as I doubt not, he has surpassed himself in no other philosopher than the world, for want of a thorough knowledge of his writings, ever estimated him; so, here he appears a much greater physician than he generally seems to have passed for.

It is true, in *Algebra*, in every of introduction, the subjects of philosophy to mankind, he manifested an uncommon and in diseases, and the human structure; but, I know not how, his scientific enquiries were confined to his reading, and not to the

# MEDICINE.

When wanting the proper opportunities of using the remedies applied in particular cases, he was obliged to make his medicines experiments of other hands, and may judge from what appears, that persons who admitted any of his medicines used them with as much courtesy as to bring him an account of the success, when the wish of success attended their medicine, he was to be told is in the most elegant manner, and with great other things, it possibly is, that Mr. Boyle's *Algebra* was intended as a species for the patient, which, in a physician's medicine, when rightly used, is the object, followed, if it just performs the cure.

On the other hand, our author was well aware of the accidents and uncertainties which attend such experiments. He tells us expressly, that he does not so depend on his experiments with the same positiveness he does with the philosophical experiments, and thus his reputation upon the subject of medicine is preserved. **LII 2** I have not, however, fully, nor have I, spent numerous volumes, regarding the virtues of particular remedies, which may be good, without being infallible. We may take him, then, upon the whole, as

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MEDICINE.

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## The P R E F A C E.

*WE have now traced Mr. Boyle to the last stage of his philosophical works, that of medicine. And, as I doubt not, he has hitherto shew'd himself a much greater philosopher than the world, for want of a thorow knowledge of his writings, ever esteem'd him; so, here he appears a much greater physician than he generally seems to have passed for.*

*'Tis true, in shewing, by way of introduction, the usefulness of philosophy to medicine, he manifested an uncommon skill in diseases, and the human structure; but, I know not how, his philosophic capacity appears to swallow up his medicinal one, till we come to consider him strictly as a physician; and then he shews a masterly genius, and a very wide command in medicine. But never actually taking the profession upon him, and, consequently, often wanting the proper opportunities of seeing the success of remedies applied in particular cases, he was generally obliged to make his medicinal experiments by other hands. And if we may judge from what appears, those persons to whom he committed any of his medicines with this view, were seldom so uncourtly as to bring him an account of their failure; but when the wish'd success attended their exhibition, he was sure to be told it in the most obliging manner. And hence, to omit other things, it possibly is, that Mr. Boyle recommends *Ens veneris*, as a specific for the rickets; which, tho' a serviceable medicine, when rightly tim'd in this disease, seldom, of it self, performs the cure.*

*On the other hand, our author was well aware of the accidents and uncertainties which daily occur in practice. He tells us expressly, that he does not set down medicinal experiments with the same positiveness he does those in philosophy; nor centre his reputation upon the success of any receipt or process in medicine. These, however, "says he, "I always deliver faithfully; nor have I, upon uncertain rumours, recorded the virtues of particular remedies, which may be good, without being infallible." We may take him, then, upon the whole, as*  
a phy-



## The P R E F A C E

a physician; for he, doubtless, makes good the character: and, had it been his fortune to have practised the art, he would, I question not, have improved it still more than he has. He had a strange sagacity in discovering the origin of diseases; he appears to have thoroughly considered their manner of acting upon the human frame; and to have hit upon the method of curing them by very plain and simple medicines: witness the piece which concludes this last general head of our abridgment.

There are some, indeed, who have thought fit to censure that admirable collection of remedies, as worthless: and truly we should have been obliged to them, if they had furnish'd the world with a better: but till this is done, which, I am afraid, it will not soon be, we are to consider, that our author's view was here to offer the generality, and such who live at a distance from physicians, a set of remedies, which might soon, with little trouble, and great cheapness, be prepared, as occasion required. And will any man say, that the book does not answer this design? Where, then, lies the cause of blame? The remedies, cries one, are simple, such as the good women prescribe, and some of them appear ridiculous. But we are to know, that Mr. Boyle, if the nature of his design had required it, could have prescribed as elegant compounds as any physician who has wrote; but of such he had, for weighty reasons, no great opinion; and these simple ones answer his end much better than the other. The remedies contain'd in this collection too, had been long experienced, and found effectual, before he communicated them to the public.

'Tis, we must own, a difficult thing to set down a large number of simple, serviceable, and experienc'd remedies, and keep them from appearing ridiculous to such as have seen little in physic; but the men of experience and of judgment in the art, who know how slight and how unpromising a remedy sometimes, apparently, performs great cures; and how powerful and experienc'd ones sometimes fail, are not forward to censure a medicine for appearing contemptible, especially after it has been tried, and found effectual.

In short, whoever publishes a collection of remedies, well adapted to the occasion, approved by experience, easy to be procured, and cheap in the purchase, all which recommendations go along with these of Mr. Boyle, cannot but deserve well of mankind.

# MEMOIRS

## FOR THE

# NATURAL HISTORY

O F

Extravasated human Blood, especially  
its spirit.

1. **T**HE colours of human blood, arterial and venal.
2. Its taste.
3. Its odour.
4. Its heat when fresh emitted.
5. Its inflammability, and some other qualities.
6. The aerial particles naturally mix'd with human blood; and also found in its distinct parts.
7. The specific gravity of human blood entire.
8. The specific gravity of the two obvious parts of human blood, the red and serous.
9. The consistence of entire human blood.
10. The disposition of it to concrete, and the time wherein it is performed.
11. The liquors and salts that coagulate human blood.
12. The liquors and salts that hinder its coagulation, or dissolve it when coagulated.
13. The liquors, &c. that preserve human blood.
14. The mixtures it may admit from aliments.
15. Its spontaneous or natural analysis, into a serous and a fibrous part.
16. The respective quantities of the serous and fibrous parts.
17. The differences between the serous and the red part.

*Heads for the  
natural history  
of human blood,  
in an healthy  
state.*

18. The

18. The artificial or chymical analysis of human blood; and first of its spirit.
19. The volatile salt of human blood, and its figures.
20. The phlegm of distilled human blood.
21. The two oils of human blood.
22. Its fixt salt.
23. Terra Damnata.
24. The proportion of the differing substances, chymically obtained from human blood.
25. The fermentation or putrefaction of human blood, and its phenomena.
26. The mechanical uses of human blood, as in husbandry, &c.
27. The chymical uses of it.
28. The medicinal uses of human blood.
29. The difference between human blood in sound persons of different constitutions, and in different circumstances, as men, women, children, Moors, Negroes, &c.
30. The affinity and difference between the blood of men and that of other animals, as quadrupeds, birds, fishes, and sanguineous insects.
31. Particulars omitted, relating to the history of human blood.
32. Miscellaneous observations, experiments, and inquiries about human blood.

## S E C T. I.

*The heat of human blood, newly extravasated.*

I Have learnt by inquiry, that several persons, free from a fever, have, after their blood had run out a while, upon phlebotomy, complain'd, they found it come sensibly hotter than before; and some, that it came with a degree of heat that was troublesome, and, as they fancied, ready to scald them.

I desired a chirurgeon, to put a sealed weather-glass into the porringer, wherein he was going to bleed a young gentlewoman, so that as the blood ran out of the open vein, it might fall upon the ball of the instrument; in which the liquor was made, by the warmth, to ascend about an inch.

But having procured a man of a middle age, who seemed healthy, to bleed in the same manner, upon the same weather-glass; the spirit of wine ascended above all the marks belonging to the stem, and ex-



expanded it self considerably in the small upper ball; so that tho' we could not determine how high it would have risen, if the stem had been long enough, yet it seem'd manifest, that the warmth, which made it rise, considerably exceeded the usual warmth of the air in the dog-days; these gaged thermoscopes being so fram'd, as to keep the liquor in the stem all the year long, without sinking quite into the greater ball in winter, or ascending into the less in summer.

We employed, also, when a young woman was blooded, a sealed thermometer that was not gaged, but was much shorter than the other; and in this the spirit was raised almost to the top, which argued a considerable degree of heat.

The same thermometer being plunged into some blood of a healthy man, tho' it was already coagulated, it still retained warmth enough to make the spirit of wine ascend, at least three or four fingers breadth.

Since human blood affords a considerable quantity of oil in distillation, it may well be supposed a combustible body; but every one will not think it so inflammable, as I, upon trial, found it. For having held a piece of human blood, dried till it was almost pulverable, in the flame of a candle, it would take fire, and afford a flame much like that which excited it; burning with a crackling noise, and here and there melting. But this inflammability much better appeared, when putting together four or five thoroughly kindled coals, we laid on them a piece of dried blood, of the bigness of a small nutmeg; for this yielded a large and very yellow flame; and if it were seasonably and warily blown, from time to time, as the effluvia degenerated into smoke, it would very long continue to yield clear and yellow flames, considerably large, in proportion to the body. And during a large part of this deflagration, the blood appeared, as it were, to fry upon the coals, and, in great measure, to melt into a black substance, almost like pitch. There was, also, a crackling noise produc'd, like that which chymists observe, when they decrepitate common salt.

*Its inflammability.*

These experiments were repeated with the like success. But there is another surprizing instance of the inflammability of human blood: for, having caused some to be so far dried, that it was reducible to fine powder, I took part of this powder, that had pass'd a fine sarse, and casting it on the flame of a good candle, the grains, in their quick passage through it, took fire; and the powder flashed, not without noise, as if it had been rosin. This experiment was, also, repeated with success.

The specific gravity of human blood is more difficult to determine, than one would readily imagine. For it may differ sensibly in several persons, with their sex, age, constitution, &c. and in the same person it may be varied by the time of the year, and of the day; and by being drawn at a greater or less distance from eating, &c. Besides all this, there is a mechanical difficulty attending the experiment it self; for the blood begins to coagulate so soon after it

*And specific gravity.*

**MEDICINE.** is emitted, that it is scarce practicable to weigh it hydrostatically, either by immersing into it a solid body heavier than it self, or by plunging the whole in water; the former way being opposed by the fibrous part of the blood, and the latter by the serum. And, upon the same account, it is, also, difficult to compare, with any accuracy, the weight of blood: however, it may be of considerable use, to have some tolerable estimate of the difference in gravity between water and human blood; by which so many parts of the body, consistent as well as fluid, are, by various changes of texture, both constituted and nourished.

We, therefore, took the blood of a sound man, emitted all at one time, and put the whole mass, as well the serous as the fibrous part, into an oblong glass, of the fittest size and shape we could procure. And having suffered the blood to rest till all was settled, and the bubbles vanished, we carefully mark'd, with a diamond, that narrower part of the glass, to which the upper surface of the blood reached. Then we weighed the glass and the blood in a very good balance, and having pour'd out the blood, and wash'd the glass, it was filled with common water, to the same mark, and weighed again in the same balance; afterwards the water being poured out, the glass, alone, was counterpoised in the same scales; and its weight being deducted from each of the two preceding weights, the water was found to be nine ounces, six drams, and fifty grains; and the blood ten ounces, two drams, and four grains: so that the difference between them being three drams, and fourteen grains, the blood was heavier than so much water by about the 25<sup>th</sup> part of its own weight.

*What things  
coagulate the  
blood.*

Tho' rectified spirit of wine be a menstruum, consisting of very subtile parts, and, upon that account, a good dissolvent of many vegetable substances, and, as experience has assured me, of some metallines too, which seem more solid than the fibrous part of human Blood; yet having separated from the serum, a clot of blood, that was coagulated, but soft, I kept it for several hours in a very well dephlegmed vinous spirit; from whence I afterwards took it out, as hard as if it had been well dry'd by the fire.

Having almost filled a vial, capable of containing near a pound of human blood, with a mixture of that, and some rectify'd spirit of wine, by guess a fourth, or an eighth part; at the end of above three years, looking upon the same glass, stop'd with nothing but a cork, we found it coagulated, or of a consistent form: when the vessel being unstopp'd, there appeared no sign of putrefaction in the blood; and having smelt to it, we could not perceive that it was fetid: so balsamic a vertue has dephlegmed spirit of wine to preserve it.

We took a piece of fibrous, or concreted blood, of the bigness of a large bean, and having put it into a small glass vessel, with a flattish bottom, we poured on it as much highly rectify'd vinous spirit, as might serve to cover it, tho' it had been twice thicker than it was; then

then we covered this open-mouth'd glass with another, and set the vessel in a quiet place, that the vinous spirit might have leisure to imbibe the serous, or aqueous parts of the blood, and thereby harden that soft substance: and in effect it quickly seemed to have gain'd a superficial crust; but the internal parts continuing yet soft, we left the liquor upon the blood for a day or two longer; and then found, that the action of the liquor had quite penetrated the lump of blood, and made it moderately hard and friable.

Having separately put small quantities of several acid liquors, as *Aqua fortis*, oil of vitriol, and spirit of salt, to blood, whilst warm, as it came from the animal, I found they presently turn'd it to a dirty colour, and coagulated it; on the other hand, fine urinous spirits would make it look more florid, keep it more fluid, and long preserve it from putrefaction.

I caused some of the consistent part of human blood, to be, in an open shallow glass, exposed to the air in a frosty night, and the next morning found it to be lightly frozen, and the surface of the ice prettily figured with images of combs, having teeth on both the sides or edges; on which account these figures did not ill resemble those I have often obtained, by slowly coagulating into salt, a solution of sal-armoniac made in common water.\*

M m m 2

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\* Dr. Freind, upon mixing various medicines with the fresh arterial blood of a dog, Feb. 12. observed as follows.

With *Spir. Nitr. dulc.* the blood immediately turn'd blackish, and became a very thick mass; and both the blackness and thickness were increased on Feb. 13. *Spir. Salis dulc.* turn'd the colour very brown, but render'd the substance less thick than the spirit of nitre. *Spir. Nitr. Bezoart.* presently turn'd the blood into a strong coagulum, as if it had been putrefied. On Feb. 13. a very small part of it remain'd thin, but brownish. Oil of vitriol soon made it concrete, and caused a fermentation: its colour was blackish. On Feb. 13. the coagulum was less strong than in the others; the serum being separated from it. Spirit of nitre fermented and coagulated the blood, and gave it a brownish hue. On Feb. 13. very much serum, lightly concentered, appeared on the top. *Aqua fortis* made a fermentation, and a strong coagulation. Feb. 13. the mass was black, thick, and clotted; but the serous part less so, than with spirit of nitre. The juice of birstort gave almost the same phenomenon. Spirit of salt

turn'd it much blacker than the *Spir. Salis dulc.* and made it of the thickness of a syrup; and thus it appeared, Feb. 13. The philosophic spirit of vitriol caused a fermentation, and a coagulum of an ash colour. Distill'd vinegar made a soft coagulum, of a colour a little dusky. This coagulum was stronger, Feb. 13. and more black. The *Tinct. Antiphthisica* made a clotted mass of a dusky colour; and thus it appeared Feb. 13. Spirit of vitriol made a very thick, muddy-coloured mass. Balm of Gilead thicken'd the blood exceedingly, and made it appear as if 'twere putrefied. Salt of steel, and salt of vitriol, coagulated it; but left some part fluid. *Saccharum Saturni* made a middle concretion of a vivid colour. *Sal Prunel.* made a mass somewhat clotted. The juice of ladies-mantle precipitated a black, clotted mass, and left the other part sufficiently fluid. *Freind Emmenolog. p. 176, 177.*

With spirit of sal-armoniac, the colour was exceeding florid, and the substance fluid. On the 18. it remained fluid, but appeared somewhat blacker. A decoction of favin, and of hore-hound, increased the redness and fluidity more than did the spirit



## MEDICINE.

*The volatile salt of human blood, heterogeneous.*

The volatile salt of human blood, tho' very fugitive, is yet so fusible, that if it be dextrously managed, one part of it may be brought to melt, and, as I have tried, even to boil, whilst the rest is flying away. The like I have tried with some other volatile salts, and, I presume, the observation will hold in most, if not in all of them.

Tho' the volatile salt of human blood, when 'tis, by sublimation, made white and clean, seems to be very homogeneous; yet I am apt to suspect, either that its substance is not altogether similar, or that its component corpuscles are of different sizes, and perhaps of different shapes. For having weighed out some grains of a re-sublimed salt of human blood, that seemed very pure, the odour was so strong and diffusive, that one would have expected the whole salt, being but six grains, should, in a few hours, evaporate away; especially being left in a south window, exposed to the air on a flat piece of glass: yet seven or eight days after, the salt seem'd to have wasted but little; and what remain'd, had scarce any odour at all: notwithstanding which, this white body retain'd a saline tast; and a little of it being put upon a solution of common sublimate in fair water, readily turn'd it white. Whence it seem'd, that the penetrating and diffusive odour of the volatile salt of blood proceeded from some particles much more subtle and fugitive than the other parts which compos'd it.

*Its temperature.*

A dram of volatile salt of human blood, sublimed in a lamp-furnace, was put into as much common water, as in a narrow cylindrical glass served to cover the whole ball of our standard thermometer, and

spirit of sal-armoniac. Sydenham's liquid laudanum, spirit of hartshorn, the juice of sage, lavender, master-wort, penny-royal, and wormwood, made it more florid, but not much thinner than the decoction of safin. Feb. 13. the colour turn'd a little brownish. Jones's panacea of opium had the same effect with the laudanum; only on Feb. 13. the colour was less bright. Both rue-water and wormwood-water gave it a very great degree of fluidity, which remain'd unaltered on Feb. 13. Spirit of wine turn'd it to a coagulum, tough as bird-lime. On Feb. 13. it resembled the conserve of hipps, both in colour and consistence. Spirit of wine with camphire, and a tincture of opium made with it, had the same effect; only the coagulum was less viscid. The tincture of Peruvian bark made with spirit of wine, render'd the blood exceeding thick and dark. On Feb. 13. 'twas somewhat brighter; but strongly concreted. Wine saturated with the

same bark infused in it, gave it a very great degree of fluidity, and a most beautiful colour. A tincture of jalap, of scammony, and compound spirit of lavender, made the colour strong and bright, and the substance thick. Tincture of amber and of tartar, turn'd it into a dusky colour and clots; and on Feb. 13. it was pretty strongly coagulated. Calomel gave it a vivid red, and a great degree of fluidity; much serum floating on the top. Æthiops mineral precipitated a black mass out of it, and left the other sufficiently thin. Salt of broom gave it a vivid colour, and a greater degree of fluidity than is natural to it. Salt of wormwood greatly increased its colour and fluidity. Salt of tartar altered not its colour, but render'd it somewhat thicker than did salt of wormwood. Lower's chalybeate tincture made it very red and thin; something like an oily froth swimming on the top. *Emmenolog.* p. 160, 161.

when,

when, after this had stood a while in the water, in order to become of the same temper with it, we put in the salt, the tinged spirit of wine manifestly subsided about two tenths of an inch, and probably would have fallen lower, if there had been more water in the vessel, to make a seasonable solution of the salt, whereof a considerable part lay undissolved at the bottom. MEDIC. NB.

When we perceived the liquor to subside no more, we put to it, by degrees, some strong spirit of nitre, till it would no longer make any manifest conflict with the dissolved salt. The event was, that the liquor in the thermometer began presently to mount, and continued to do so as long as the conflict lasted; at the end of which we found, that it had ascended more than three inches and a half, above the station it rested at when the ebullition began.

The figuration of the volatile salt of human blood may be considered, either in regard of the single grains, or of that aggregate of them, which, when made to ascend to the top of the glais, may be call'd its sublimate. The latter of these may be best observed, when the saline exhalations first ascend, and fasten themselves to the inside of the glass that is set to receive them. For tho' towards the end of the operation, the corpuscles lie so thick and confused, as to leave no distinct figures; yet, at first, one may often observe the little saline concretions placed in rows, sometimes streight, and sometimes more or less crooked, with differing occurrences and coherencies; so that tho' sometimes such rows of concretions may represent either trees, their branches, hartshorn, &c. yet these seem not to be constant representations, depending upon the particular nature of human blood; but casual figurations, that depend upon several accidental causes and circumstances; such as the degree of fire employed to sublime the salt, &c. Nor is the salt of human blood the only volatile one, among whose elevated concretions I have observed the like circumstances to produce diversity of configurations. But as to single grains of the volatile salt of blood, I discerned many of them to be finely shap'd; tho' whether it were accidental or not, further tryal must inform me. I could not, that I remember, observe these handsome figures in the concretions which compos'd the sublimate, obtained by rectifying, or elevating again, the salt that first came over, but in the grains that, in the first distillation, fasten themselves to the upper part and sides of the receiver; for several of these were of considerable bigness and solidity: and tho' they were not all of the same shape; some of them being not unlike to cubes, others to parallelpipeds, and others to octoedrons; yet most of them were prettily shaped, being comprehended by smooth planes, finely figured, and aptly terminating in solid angles, as if the concretion had been cut and polished by a jeweller.

There is another way that I have used to observe the figures of the salt of blood; which was to rectify the spirit of blood, so that it might be fully satiated with the salt, whilst the liquor (in the receiver)

*Its figures.*

MEDICINE.

ver) continued yet somewhat warm. For then setting aside this over-impregnated liquor; when it came to be quite cool, there appeared at the bottom of the vial a large number of saline concretions of differing sizes; several of which, as far as the rest would suffer me to see them, were shot into crystalline plates, very smooth, and prettily figured; having their broad and parallel surfaces of a hexagonal or regular octogonal figure.

We took a dram of dry volatile salt of blood, and having dissolv'd it in distill'd water, we dropt into it good spirit of nitre, till the two liquors, tho' they were shaken, would no longer manifestly act upon one another; the conflict being ceas'd, we slowly evaporated the superfluous moisture, which steam'd almost all away before the saline part would coagulate. At length it became dry, and then the middle part appeared in the form of thin crystals, like those of salt-petre; but the rest, which was by much the greater part of the concretion, seem'd to be a confused mass, without any distinct figure. This mass weighed but one dram and twelve grains; so that, as far as this single experiment can inform us, the volatile salt of blood may be satiated by a fifth part of its weight of the saline corpuscles of spirit of nitre. This compounded salt being laid in a window, appeared apt to resolve by the moisture of the air; and a little of the said salt being put on a well-kindled coal, readily melted, and seem'd to boil, and towards the latter end, made a noise, and afforded a flame very like common nitre, only its colour was more yellow. The strong smell that accompanied this deflagration, was like that peculiar to spirit of nitre.

To try how much volatile salt an assigned quantity of water wou'd dissolve, we took three ounces of distill'd water, and put into it, by degrees, some dry white salt of sal-armoniac, keeping the liquor in digestion till it had dissolved as much as it cou'd; then we took it out, and found, that after standing for some hours in the cold, there settled about the bottom of the glass, a considerable quantity of salt, supposed to be two drams; which being deducted from two ounces, which had, in all, been employed, there remains once ounce and six drams in the liquor, which, by this account, had dissolved above half its weight of salt.

*Disposition to  
dissolve in wa-  
ter.*

Having caused an ounce of distill'd water to be carefully weigh'd out, we put into it, little by little, some dry white volatile salt of blood, and shook it well into the liquor, to make it disperse the better; we allowed it, also, a competent time for solution, and by this means found, that one ounce of water would dissolve at least two drams, that is, a fourth part of its weight, of dry salt, and that in the cold. Afterwards, by the help of heat, we made the same liquor dissolve near five and twenty grains more.

We put this solution into a retort, to be drawn off with a quick heat, and thereby had a distill'd liquor, that contain'd all the volatile salt,



salt, except a little that escaped in a dry form; which liquor tasted strong enough to pass for as brisk an one, as moderate spirit of blood, drawn in the common way; and consequently discovers what proportion should be taken, of the aqueous ingredient to the saline, to make such a spirit.

And having ordered the vial that contained this aqueous spirit, to be kept stopp'd during a frosty night, we perceived at the bottom of the glass a pretty deal of volatile salt, coagulated or shot into crystals, which were fine and clear, and some of them larger than spangles; yet being much more numerous than we desired, and adhering closely and confusedly to one another, they kept us from discovering the figure of the particular grains; and made me doubt, whether the single crystals were of the same shape; all that I could clearly discern being, that several of those concretions were flat thin plates, with fine rectilinear angles, that inclin'd us to think, if the whole plains could have been perfectly discovered, their broadest surface would have been hexagonal, or of some polygone figure, very near of kin thereto.

*And to freeze  
and be frozen.*

We put an ounce of distilled water, wherein was dissolved as much volatile salt of human blood as it would well take up, into a glass egg, and exposed it, during a frosty night, to congeal; hoping to discover, whether, as the saltiness that is in sea-water keeps it, here in *England*, from freezing, so the volatile salt of human blood, which much resembles the other in taste, would have the like effect upon water, especially if it were fully impregnated therewith. To this conjecture the event was answerable; the frost having produced no ice in our solution, nor so much as made any of the salt manifestly shoot. And tho' afterwards we remov'd it into a frigorific mixture, that would, probably, have frozen beer and ale, and, perhaps, the weaker sort of *French* wine; yet we did not perceive it to turn any part of our solution into ice; but only made it let fall a pretty deal of matter that seemed feculent.

Sea-salt dissolved in water, renders it much more difficult to be frozen than it was before; yet being join'd with ice or snow, the other ingredient of our frigorific mixture, it does, when outwardly applied, very much conduce to the artificial congelation of it; which usually would not succeed without it. Wherefore, to try whether, as volatile salt of human blood, being dissolved in water, hinder'd it from freezing, so it would, outwardly apply'd, highly promote its glaciation; we mixed about a scruple of this salt, with a convenient quantity of beaten ice; and having put into this mixture a slender pipe of glass, with common water in it, we found, after a while, the water that lay in the lower part of the glass vessel, and was surrounded by the mixture, turned to ice.

Human blood, like most of the other subjects of the animal kingdom, that I have had occasion to examine, afforded, by distillation in a retort,

*The oils of  
human blood.*

**MEDICINE.** retort, an empyreumatical and very fetid oil, whose colour was almost black; but that seem'd to proceed only from the intense and opaque redness of the liquor, since some portions of it being viewed against the light, when spread very thin upon glass, appeared of a deep yellow, or of a reddish colour, as they chanced to lie more or less thick.

When the blood was well dry'd, before we committed it to distillation, I found it to afford a greater quantity of oil, in proportion to the weight of the dry body, than was at first expected. Once, out of a pound of it not over-dry'd, we had near an ounce and an half of oil; and from another parcel, we had it in a far greater proportion to the quantity of blood that afforded it.

Having prepared blood, by a very convenient digestion, and rectified, very carefully, the distilled liquors that came over, with the flame of a lamp; I obtained, among other things, two oils of very different colours; the one of a yellow, or pale amber, and the other of a deep red. But it was surprizing, that tho' these oils were both of them afforded by the same blood, and were clear and pure, yet they would not only swim in distinct masses one over another; but, if they were confounded by being shaken together, would gradually separate again, as common oil and water. Whether the difference in specific gravity between these two oils, could keep them from permanently mixing, as it kept their masses distinct before they were shaken; or whether this seeming antipathy proceeded from some particular disagreement in the textures of these liquors, I shall not here consider.

Suspecting that the oil of blood might contain saline particles, capable of being separated from it, we took a parcel of unrectified oil of human blood, and having put to it a convenient quantity of distill'd water, we thoroughly confounded these liquors by frequent agitation, that the water might rob the oil of its separable saline corpuscles; and after the liquors were well settled, the water was found impregnated with saline corpuscles, that it had, by dissolution, obtained from the oil; by virtue of which, it was endowed with a moderately brisk taste, would readily turn syrup of violets green, precipitate a white powder out of a solution of common sublimate, and otherwise resembled weak spirit of human blood.

We put some unrectified oil of human blood, into a concave piece of glass, and having dropt into it as much oil of vitriol, as might amount to a fourth, or a third part of the fetid oil, we stirr'd them well together with a slender piece of solid glass; by which means the mixture was made to send up abundance of whitish fumes, or smoke, and grew so hot, that tho' the quantity was above a spoonful, yet, without pain and inconvenience, I could not hold my finger underneath the containing glass.

Having taken some unrectified oil of human blood, tho' in that state it appeared gross, dark, and muddy, yet it would readily, even  
in

in the cold, dissolve in, or mix with high rectified vinous spirits, to which it communicated a deep reddish colour. MEDICINE.

I do not remember to have any where met with an account of the qualities of the fixed salt of human blood, and I know not whether any one has prepared it; and no wonder, since to obtain so much as one ounce of it, there is requisite a considerable quantity, perhaps some pounds of blood; and the calcination requires so obstinate a fire, that a man's patience may easily be tired before the operation be perfected; or, by the small appearance of calcination, that the *Caput mortuum* will afford him, after having been kept for three or four hours in the fire, he may be induced to conclude, that all the salt of blood is volatile in a large fire; and, consequently, that it will yield no fixt salt.

Fixed salt.

But having, by an obstinate calcination, obtained between three and four drams of this salt, I found not that it was a fix'd alkali, or a lixivate salt, but rather of the nature of common or sea-salt; tho' not without some little difference, which discover'd it self by some nice trials. But, in the general, our salt was scarce distinguishable from marine salt; for it tasted very like that; and a strong solution of it did not readily turn syrup of violets green or greenish, nor precipitate a brick-colour'd, a brownish yellow, or a white powder, out of a solution of sublimate. I also found, that the spirit of salt did not dissolve it as an alkali. Having put some oil of vitriol upon a little of our dry salt, that immediately corroded it, with great violence, and with much foam and smoke, as it does common salt. We, also, dropt a little of our fix'd salt, dissolved in distill'd water, upon a solution of fine silver, made in *Aqua fortis*, whence immediately ensued a large precipitation of a white powder. And, lastly, having put some leaf gold into *Aqua fortis*, and added a little of our powder'd salt to the liquor, it was thereby turned into a kind of *Aqua regia*, and did in a trice, without the assistance of heat, totally dissolve the gold.\*

A far greater calcination than one would expect, is required to obtain the *Caput mortuum* of human blood, which affords but very little of it. For from twenty four ounces of dry'd blood, we could get, after two days calcination, but two drams, and nine grains of

*Caput mortuum.*

\* That an acid, or what is commonly called so, and judged of by the change of colour it causes in syrup of violets, &c. may be drawn from the blood of animals in general, and from human blood in particular, seems proved by the repeated experiments of M. *Homburg*; who, for greater security in the analysis he made of them, employed for his addition only the *Caput mortuum*, or friable spongy coal of animal blood it self; whilst M. *Vieussens* made use of bole, &c. in his di-

stillations. From hence, and from the careful analyses which this great chymist has also made, of plants, and the flesh and excrements of several animals, particularly the human; it appears, that the acid, (or sea-salt,) of the aliment taken into the bodies of animals, is not destroyed therein, but passes into the substance of them; the superfluous portion being return'd unalter'd along with the excrements. See *Memoir. de l'Acad. A. 1712. p. 9—18. and p. 352—363.*



**MEDICINE.** earth. And tho' this were so carefully made, that it may very probably be suppos'd to deserve the name of *Terra damnata*, better than most substances to which chymists usually give that appellation, yet one may suspect, that this itself was not pure elementary earth; since it had a red colour, very like that of colcothar of vitriol.

*The proportions of its principles upon a chymical analysis.*

The quantities of the principles, or rather of the several differing substances obtainable, by distillation, from human blood, are very difficult, if possible, to be determined; because of the great disparity, as to proportion, that may be met with, of the fibrous, or concreted part to the serum, in the blood of different persons, and even of the same person, according to different circumstances; and because it is more difficult to distil even the dried and pulverable part of blood, without addition, than those who have not try'd will easily imagine: and I doubt few have try'd it well, because I have not met with any who take notice of the necessity of shifting the retort, to gain as much volatile substance as may be obtained, and leave as little as possible in the *Caput mortuum*. For when we distilled a considerable quantity of dry'd blood, tho' it was warily done by an expert artist; yet the same heat that made the lower part of the blood pass, in the form of exhalations, into the receiver, made the subject so swell, that it rais'd to the upper part of the vessel a considerable quantity of black matter, which an ordinary operator would have thrown aside for *Caput mortuum*, tho' a heedful eye might easily discern it to be much of the same nature with what was first put in, but blacked by the ascending fumes. We, therefore, took it out, and mixing it with the remaining substance, that was less remote from the nature of a true *Caput mortuum*, it was again, in another retort, committed to distillation; whereby we obtained more oil, &c. And perceiving even this seeming *Caput mortuum* had, at the top of it, a pretty deal of matter, that I did not think sufficiently dispirited; I caus'd it to be taken out, and distill'd in a fresh retort, in which it afforded a considerable quantity of volatile matter.

And having thus, in three retorts, distilled twenty-four ounces of dry'd human blood, we obtained of volatile substances, I mean spirit; together with a little phlegm, white salt, and a very high-coloured oil, thirteen ounces, and one dram; besides several parcels of thick oil, that stuck to the retorts and the receivers, which we estimated at seven drams more. So that the whole quantity of the volatile part amounted to fourteen ounces, of which we found the oil to be about three ounces, and six drams; and the clear liquor six ounces, three drams and an half; besides the volatile salt, which, when the spirit was drain'd from it, appeared white, but wet: for which reason 'twas not possible to determine exactly, neither how much liquor it yet retained, nor, consequently, how much it self weigh'd. But having carefully sublimed the salt, there remained in the glass two drams, and about five grains of phlegmy liquor, which was not judged free from

from salt, tho' it could not by that operation be separated. And of volatile salt, in a dry form, we obtained one ounce, two drams, and an half. The *Caput mortuum* amounted to above eight ounces and an half; which being calcined, for two days together, afforded only brownish red ashes; whence we obtained seven drams and a quarter of white and fix'd, but not truly lixivate salt; and two drams, and nine grains of earth. But in this troublesome experiment there occurred many necessary operations, in each of which we could scarce possibly avoid losing some, and now and then a considerable portion, of the matter.

I caused twelve ounces of dry'd blood to be carefully distill'd, and the distillation being ended, we found that the twelve ounces had yielded five of volatile salt and spirit together, of which we poured off from the wet salt thirteen drams, and fifty-four grains; so that there remained three ounces, two drams, and six grains of volatile salt; of fetid oil there were two ounces; of *Caput mortuum* four ounces and two drams; so that, in spite of our care, there were lost about six drams. The four ounces and two drams of *Caput mortuum* being diligently calcin'd, afforded but six drams and a half of ashes; of which very great decrease, the consumption of the more fix'd oleaginous part seem'd to be the cause. And if so, we may suppose there is a far greater proportion of oil in human blood, than has hitherto been taken notice of. These ashes were not white or grey, as those of other bodies use to be, but of a reddish colour, much like that of bricks; and yet my assistant affirm'd, he could easily know them to be true ashes, because, whilst there remained any thing oily or combustible in the *Caput mortuum*, it would look like a thoroughly kindled charcoal; but when that combustible substance was quite wasted, the remaining *Caput mortuum* look'd, in the fire, like dead and ordinary ashes; tho' when they were cold, they appeared and continued red. These ashes being carefully elixivated, afforded five scruples of white fix'd salt, besides a little, which being casually got into the contiguous sand, but thence recovered by water, and reduced to the like white salt, amounted to about a scruple more. So that there remain'd for the *Terra damnata*, thirteen scruples and about a half; that is, above twice the weight of the salt: whence it appears, that, according to this analysis, the pure fixed salt of human blood is but between the 57th and 58th part even of dry'd blood; and, therefore, probably amounts but to the 150th, or, perhaps, the 170th part (in weight) of blood, as it flows from the vein opened by a lancet: and the fix'd earth, or *Terra damnata*, is to the dry'd blood that affords it, as 19, and about a half to 1.

An entire parcel of human blood, weighing ten ounces, and seventy three grains, being slowly distilled to dryness in a head and body on a digestive furnace, afforded of phlegmy liquor seven ounces, two drams, and forty-seven grains; and of *Caput mortuum*, or rather of dry sub-

**MEDICINE.** stance, two ounces two drams. This pulverable matter being beaten, put into a retort, and distill'd in sand, by degrees of fire, afforded two drams forty-eight grains of oil. But there happen'd an unlucky mistake about the salt and spirit: for after the latter was poured off, which weighed but forty-eight grains, the wet salt, which stuck in a large quantity to the lateral and upper parts of the receiver, instead of having been wash'd out, with the phlegm of the same blood, was wash'd out with distill'd water, whence we obtain'd by sublimation, into the neck of a glass-egg, one dram and five grains of dry salt. But, by the tast of the distill'd water, whence it was sublimed, it appeared, that all the salt had not been rais'd: I, therefore, put to it as much good spirit of salt as I supposed to be at least sufficient to satiate it, with design to try, whether by evaporating this mixture to dryness, and subliming the salt by the help of an alkali, we might not recover the volatile salt, that had been somewhat fixt by the acid spirit. The retort being broke, that the *Caput mortuum* might be taken out, it was found to weigh six drams and twelve grains; which being carefully calcined, yielded but two scruples and four grains of ashes, which were red. These being elixiviated, afforded eighteen grains of salt, besides the remaining earth or terrestrial substance, which I keep by me; because, notwithstanding all the violence of the fire it has undergone, 'tis of a red colour, with an eye of purple.

## S E C T. II.

Observations  
upon the serum  
of human  
blood,

**A** Young man having bled into a porringer, and the blood having been kept for several hours, that a sufficient separation might be made of the consistent part and the fluid; they were separately weigh'd, when the former amounted to about six ounces, and the serous part to near the same weight.

Since the division that nature her self makes of human blood, when being let out of the veins, and suffered to cool and settle, is into a fluid or serous, and a consistent or fibrous part; and since 'tis often found, that the former of these parts either equals or exceeds the latter in quantity, I thought it might conduce to shew the nature of the blood, to make some tryals upon the serum apart.

Its proportion  
to the red part.

And first, having weigh'd the serum, and the consistent part of a parcel of human blood, obtained, at once, by a single phlebotomy, we found the latter to be four ounces six drams and an half, and the former three ounces and six drams. And having made the like tryal with another parcel of blood, drawn from another person, the fibrous part weighed four ounces, five drams; and the serum four ounces. But tho' in both



both these tryals the weight of serum that appeared in one mass, was MEDICINE. inferior to that of the fibrous part; yet it could not be safely inferred, that, absolutely speaking, the fibrous part of either of these parcels of blood exceeded the other; since we weighed only the serum that we found in a distinct mass; whereas a multitude of serous particles may well be supposed to be lodged between the parts of the consistent mass; for, probably, 'tis upon account of the interspersed serosity that it is lost; and besides, it affords a great deal of aqueous liquor. And this may sufficiently appear by the following experiment, which was purposely made, to examine the conjecture.

We took a porringer of blood, wherein the serum was separated from the fibrous portion, that was coagulated into one consistent mass; and having carefully poured off all the fluid part, we put the remaining mass (which weighed four ounces, five drams, thirty-four grains) into a small head and body, and distill'd it in a digestive furnace, till the matter, left in the bottom of the cucurbit, was quite dry; then taking out the separated parts of this red mass, the dried portion was found to weigh one ounce, three drams, thirty-four grains. But the serous liquor that pass'd into the receiver, being limpid and aqueous, without any shew of salt or oil, amounted to three ounces, fifty-three grains. We repeated this experiment with the fibrous part of another parcel of human blood, and found the dry mass, remaining in the cucurbit, to weigh one ounce, six drams, and fifty grains. But the phlegmy liquor, distill'd from it, amounted to seven ounces.

Having hydrostatically examin'd the serum of human blood, we found it heavier than common water. For a piece of red sealing-wax, being suspended in a good balance by a horse-hair, was found in the air to weigh one dram fifty-six grains, and in the water thirty-five grains; but in the serum only thirty-three grains. This trial was confirmed by a more exact one, made with an instrument that I purposely designed for weighing liquors nicely; in which, when common water weighed two hundred fifty-three grains, an equal bulk of serum weighed three hundred and two. And supposing different serums of human blood would not be of equal specific gravity, I try'd that of the blood of another person in the same instrument, and found it to weigh two grains less, that is, three hundred grains in all. \*

We

\* Some experiments made by Dr. Jurin, shew, that the red part of the blood is specifically heavier than the serum; that the red globules are not filled with any elastic fluid; that the specific gravity of the serum, drawn off from the red part, is, at a medium, to water 1030. to 1000; but the specific gravity of the blood it self as 1054; whence blood is heavier than serum by about one. part in 43; that the serum,

which may be poured from the *Craffamentum*, with the quantity remaining in the interstices of the latter, is, probably, about three fourths of the whole; and that the red part of the blood consists of some phlegm, united with oil and salts, and a small quantity of earth. But, adds this learned gentleman, what is the exact proportion of these several principles to one another; what alterations are produced;

## MEDICINE.

We once employed some serum which was not poured off so clear, but that it appeared of a reddish colour; and tho' we filter'd it thro' cap-paper, yet a large number of the tinging corpuscles were so thoroughly mixed with it, that the liquor pass'd thro' the filtre of a yellow colour.

*The serum of human blood mixed with various substances.*

To try whether acids would coagulate our serum, as I had found they would some other animal liquors, I dropt spirit of salt into it, which immediately produced some white concretions, that quickly subsided to the bottom, and there appeared like a very light and tender cheese-curd.

The like operation, but more powerful, oil of vitriol had upon another parcel of serum. We also dropt into some of our liquor, good spirit of sal-armoniac, which made it rather more fluid.

To try whether these precipitations did not more proceed from the coalition and texture of the acid salts and the serum, than barely from the peculiar action of those salts as acids, we dropt into another portion of our serum oil of tartar *per deliquium*, which instantly produced a white curd, as the spirit of salt had done, but not, as it seem'd to us, so copiously. We poured, also, upon some serum highly rectified spirit of wine, which presently coagulated part of it into a large white curd, that appeared much lighter than any of the former; for it would not, like them, subside; but kept at the top of the liquor.

To try, also, what a salt compounded with a metal, would do upon our serum, we put to it a little strong solution of sublimate, with which it presently afforded a white and curdled substance.

We put some of our serum upon filings of steel, but by reason of the colour of the liquor it self, we could not satisfy our selves about the event. And tho' we afterwards put another parcel of serum upon filings of the same metal, yet neither did this give us satisfaction; because the vial having been mislaid, it was not viewed again till many days after; at which time the liquor was grown so thick and muddy, that we could not well discern any more of the colour, than that it was somewhat dark, but not either black or blackish; yet by a tryal or two, that we made with a little of this liquor, it seem'd to have dissolved some part of the steel: for putting it to some fresh infusion of galls made with water, it presently afforded a large precipitate; tho' this was so far from being inky, that it was not so much as dark coloured, but rather whitish. And having mixed with some

ced in the body by the change of this proportion; how, and in what part the red globules are form'd; by what means they preserve their figure, without dissolving in the serum, or uniting with one another; what variations are made in their specific gravities by heat and cold, with

the effects of those variations, are questions not very easy to be solved, and yet of such importance to the animal economy, that it were greatly to be wish'd we had sufficient *Data* to determine them. See *Philos. Transf.* No. 361. p. 1000.

of our impregnated serum, a convenient quantity of infusion of galls, MEDICINE.  
made in a highly rectified vinous spirit, the two liquors not only  
afforded a kind of coagulum, or precipitate, but being left together  
for some hours, associated into a consistent body, wherein the eye  
discovered no distinct liquor at all.

But expecting better success, by putting some of our liquor upon  
filings of copper, which when wrought upon by bodies that have in  
them any thing of urinous salt, give a conspicuous tincture; we found,  
accordingly, that the metal had in a very few hours discoloured the  
menstruum: afterwards, the vial being left unstopp'd, it began by  
degrees to grow gradually blue; and within a day more was of a deep  
blue colour.

And, to confirm our conjecture, that this tincture proceeded from  
particles of volatile salt, latent in the liquor, we mix'd some of it with  
a convenient quantity of syrup of violets, and thereby obtained a colour,  
which, by reason of the action of those particles upon the syrup, ap-  
peared of a fine green.

Our blue tincture, or solution of copper, I thought fit to keep for  
some time, to try whether the metalline particles would, as it were,  
embalm the serum they were dispers'd through, and preserve the liquor  
from putrefaction. And, in effect, tho' the vial was left unstopp'd in  
a window for many weeks, yet I did not perceive the liquor to grow  
at all fetid.

About two ounces of serum of human blood, were left in an unstopt  
vial for twenty days, or three weeks; and tho' the glass usually stood Exposed to the  
air.  
in a south window, and in the month of July, yet, to our wonder, the  
serum did not, by the smell, appear putrefied; yet had let fall a con-  
siderable quantity of whitish sediment; but within three or four days  
after this, the liquor was found to smell offensively. We therefore  
try'd, whether this putrefaction was accompanied with any acidity,  
but could not perceive that it was; since it would not so much as take  
off the blue colour of the infusion of *Lignum nephriticum*. When it  
was in this state, we put it to distil in a low cucurbit, with a gentle  
fire, to try if from this fetid liquor, as is usual from putrefied urine,  
the spirit would first ascend: but we found the liquor that first came  
over, to be so little spirituous, or saline, that it would not in an  
hour's time turn syrup of violets green. Yet we judg'd it not quite  
destitute of a volatile alkali; because having let some of it fall into a  
solution of sublimate, it presently made a white precipitate.

We took some ounces of serum of human blood, filter'd thro' cap-  
paper, to free it from all concreted substance; and having committed  
it to distillation in a small retort, placed in a sand furnace, we obtained  
only a few large drops of a darkish red oil; some of which subsided  
to the bottom of the other liquor, but the greater part swam upon  
it. We obtained, in this first distillation, no volatile salt in a dry form;  
but after a pretty deal of insipid phlegm had been drawn off, there  
came

*Analysed by  
the fire.*



MEDICINE. came over a large proportion of spirituous liquor, which smell'd almost like the spirit of blood, and contained much volatile alkali; so that it would readily turn syrup of violets green, make a white precipitate in the solution of sublimate, and cause a great ebullition with spirit of salt. This spirit being rectified in a small head and body, there was left in the bottom of the glass a greater quantity than we expected, of a substance thick like honey; and which was, for the most part, of a dark red, and seemed to contain more oil than appeared upon the first distillation. The liquor that came over the helm seemed more pure, but not very much stronger than the first spirit. Yet having put it into a glass-egg, with a slender neck, and given the vessel a convenient situation in hot sand, we obtained a volatile alkali, that sublimed into the neck, in the form of a white salt. This should seem to argue, that the serous, or fluid part of the blood, affords the same elementary principles, or similar substances, both as to number and kind, with the fibrous and consistent part, tho' not as to quantity; that of the oil and of dry salt being less in a determinate portion of serum, than they would be in a like quantity, or weight, of the concremented part of the blood.

With additions. Having observed, that tho' the spirituous parts of human urine, require the liquor to be long digested, or putrefied, to loosen them from the more sluggish parts, and make them ascend before the phlegm; yet, if fresh urine be poured upon a due portion of quick-lime, a large part of the spirit will presently be set loose, and made capable of ascending in distillation; I thought it worth while to try, what would be afforded by the serum of human blood put upon quick-lime, before we distill'd it. In pursuit of this enquiry, we put these two bodies together, upon whose commixture there ensued a sensible, but transient heat. This compounded body being committed to distillation, afforded, first, a kind of phlegm in a gentle fire; and then, in a stronger, a moderate quantity of liquor, that was thought to smell manifestly of the lime, but had not a brisk taste; tho' accompanied with somewhat more of a high-coloured, and fetid oil, than was expected.

The other liquor being slowly rectified, the spirit that first came over had a strong and piercing smell, but less rank than that of human blood, drawn after the ordinary way. Being dropt upon syrup of violets, it presently turn'd it green; with a strong solution of sublimate in water, and another of quick-silver in *Aqua fortis*, it immediately made two white precipitates; and being mixed with good spirit of sea-salt, tho' upon their being confounded there appeared a thick, but whitish smoke; there was not produced any conflict or bubbles; tho' the colour of the spirit of salt appeared much heightened by this operation. And having put the mixture of the spirit of serum, and of salt, to evaporate, that we might observe whether it would afford a salt figured much like sal-armoniac; we found that it did not; but that the colour produced

in

in the mixture whilst fluid, was so heightned in the concretion, that it appeared of a blood-red colour; but for the shape, it was so confused, that we could not reduce it to any known kind of salt. By all which phenomena, this spirit of the serous part seems to be very near of kin to that of the concreted part of blood.

Quick-lime being suspected of a caustic and fretting quality, I thought fit to try, whether the fix'd salt of pot-ashes being substituted in the room of it, would, in distillation, have the same effect upon serum of human blood. Wherefore, to four parts of the liquor, we put one of the salt; and having distill'd them, slowly, in a glass head and body, we obtained much of a liquor, which was not judg'd any thing near so strong, as that drawn off from quick-lime. And, having put this weak liquor, afforded by our serum, to rectifie with a gentle heat, we found even the two spoonfuls of liquor that first ascended, were very phlegmy; nor would it well turn syrup of violets green, tho' it afforded some little and light precipitate when put upon a solution of sublimate.

This will seem the more remarkable from an experiment that may be sometimes of practical use, especially in physic; and may afford light to those who are studious to know the nature and preparations of human urine. We took, then, three parts of fresh urine, and having put into it one part of salt of pot-ashes, and slowly distill'd them in a head and body; there first ascended a spirituous liquor, which being set aside, we continued the distillation in a retort, till the remains appear'd dry. In the operation we obtained not one drop of oil; whilst this spirit of urine was not near so fetid, as that made in the common way; and the liquor that came over toward the latter end of the distillation, was so unlike that which the serum of blood afforded, that it was not only considerable strong, and manifestly stronger than that which first ascended, but had a penetrating and fiery taste, which left a lasting impression upon the tongue; and with good spirit of salt it made a notable ebullition, which the spirit of urine, drawn from quick-lime, did not. And tho' with this last liquor, I never found any volatile salt to ascend, in a dry form; yet in the operation made by the help of salt of pot-ashes, there came up, without rectification, several grains of volatile salt, one of which was crystalline, and considerably large.

But in repeating this experiment, we had not so good success; the liquor that came over appearing much more phlegmy than before; tho' we both times employ'd salt of pot-ashes, taken out of the same vessel; and the urine of the same person: yet this liquor that appeared so weak at its first coming over, being rectify'd *per se*, afforded more than was expected of a brisk, saline spirit; from which we easily obtained a large quantity, in proportion to the liquor, of volatile salt, in a dry form, and of a very white colour.

## MEDICINE.

*The serum of human blood long kept hermetically sealed up.* We took between two and three ounces of serum of human blood, and having put it into a bolt-head, capable of containing about four times as much, and seal'd the glass hermetically, we set it by.

After we had kept the liquor seal'd up for above a whole year, it did not appear to be at all coagulated, nor to have let fall any manifest residue; but seem'd to be as fluid as when it was first put up.

It did not appear to have bred the least worm, or maggot; and, for my part, I never observ'd worms, or insects, to be generated in blood, tho' very long kept and putrefied, provided it were fresh enough when put into the glass; and by an exact closure kept from being any way blown upon by flies, or impregnated by seminal particles, that may unexpectedly be convey'd to it by the air. Nor did there appear to the eye, any mother, or recrementitious substance, that is suppos'd, in liquors, always to accompany, and betoken putrefaction.

One design in our experiment being to try, whether the serum would, by the mutual action of the parts upon one another, or by that of some universal permeating fluid, afford so much air, as could either crack, or more violently break the glass; the tip, at which we had seal'd the bolt-head, was warily taken off; whereupon there rush'd out a pretty deal of air, with a considerable noise: and I doubt'd not that this generated air had been considerably compress'd whilst it was pent up; when casting my eyes on the liquor, to discover what change this eruption had made there, I perceiv'd on the upper surface of it, a multitude of small bubbles, such as appear in several liquors, after the air has been pent up with them, when the glasses come to be unstopp'd. And thus having seal'd up some sheeps blood, and kept it for several days in a gentle warmth; tho' the containing glass were far larger than what held our serum; yet after some time, when no violence was offer'd to it, it was suddenly blown up, with a surprizing noise, by the aerial or elastic corpuscles that were produced, or set free by the putrefaction we discover'd to have been made.

The smell of our serum was strong, tho' not cadaverous, but rather resembled that of the tincture of sulphur, made with salt of tartar, and spirit of wine; or of some such sulphureous preparation.

*And afterwards distill'd.*

One principal view I had in keeping our serum so long sealed up, was, to try, whether by a digestion, or putrefaction, for some months, it would, like urine, afford a saline spirit, or an alkali, volatile enough to ascend before the phlegm. And committing it to distillation, in a small glass head and body, in a digestive furnace, being careful to take the first spoonful of the spirit that pass'd into the receiver, we found, that tho' this liquor, at first, smell'd strong, yet the tast was not at all brisk, nor spirituous, like that usually obtained, by distillation, from putrefied urine. Nor did our liquor, when dropt into syrup of violets, presently give it any manifest greenness. Yet  
because



because I found it not insipid, I thought fit to examine it a little farther, and dropp'd a convenient quantity of it into a clear and strong solution of sublimate, in common water; by which means there was produced a whiteness, like that which spirit of urine, or volatile salt, would have made. And by this I was invited to mix some of it with a little syrup of violets, upon a piece of white paper; and also to wet with the same liquor, some small filings of copper, spread upon another piece of paper; and to leave them both, all night, in the open air, that the liquor might have time to work upon the syrup and the metal. And we found in the morning, that the former was turn'd green, and the latter so far dissolved, as to leave a large bluish stain upon the paper.

MEDICINE.

The near relation that, according to some physicians, there is between milk, and the more serous part of the blood, caused me to try, whether the serum of human blood would grow red, by being kept continually stirring over a moderate heat, with a competent quantity of salt of tartar; but in two trials we found not any redness produced; tho' one of them was made in a vessel of refined silver, with an eighth part of the salt, to one of the serum; which was the same proportion we had used, when the experiment succeeded well in milk.

An attempt to turn the serum red.

It may be needless to take notice, that the serum of human blood will, by heat, be in a short time coagulated into a kind of gelly; or rather, as far as I have observed, into a substance like a custard, as to consistence, tho' not as to colour. Having found that acid spirits, also, would coagulate serum, I thought fit to try, whether alkalies would not oppose, or retard its coagulation; and putting some spirit of human blood to a convenient quantity of serum, and causing them to be kept stirring over a very gentle fire, tho' the volatile alkali did not hinder the coagulation, yet it seemed to make it both more slow, and more soft. And this effect was yet more considerable, when we try'd another parcel of serum, with salt of tartar, instead of spirit of blood.

How serum is affected by alkalies and acids.

Human urine being observed, when frozen, to have, on the surface of the ice, figures resembling combs or feathers; the great affinity generally supposed betwixt urine and the serum, made me try, at once, whether the latter would freeze with such a degree of cold, as would easily congeal water; and whether, in case it should freeze, the ice would have a surface figured like that of frozen urine. But having for this purpose exposed some serum of human blood to the cold air, in two freezing nights successively, the serum was not found to congeal; yet I scarce doubted, but an exceeding hard frost would have produced, at least, a thin plate of ice, upon the surface of our liquor. And to confirm this conjecture, we took the same serum, and having strained it thro' a linen cloth, to separate the liquor from any clotted or fibrous parts, we put it into a shallow concave glass, and laid that

How by congelation.

MEDICINE. upon some of our frigorific mixture of ice and salt; by which means, the serum being frozen from the bottom upwards, there appeared, here and there, upon the ice, contiguous to the air, certain figures, resembling those of frozen urine.

And how  
made to serve  
for an invis-  
ible ink.

Having observed, that human urine would tolerably serve for what is call'd an invisible ink; and considering the great affinity that is suppos'd to be between urine and the serum of blood, I thought fit to try, whether the latter might not be employed, like the former, to make a kind of invisible ink. To this effect, we took some serum of human blood, and having dipt a new pen in it, we trac'd some characters upon a piece of white paper, and suffered them to dry thereon; we then held the unwritten side of the paper over the flame of a candle, by which means, the written letters appeared on the upper surface of the paper, tho' not of an inky blackness, yet of a colour dark enough to be easily legible, and very like to some others, that having been purposely written with fresh urine, and made visible by heat, were compared with them. \*

\* Dr. Freind, in mixing the following liquors with the serum of human blood, observed, that each of them turn'd it of a different colour; but that they, severally, gave it a greater degree of fluidity, which continued for a day or two. The liquors were a tincture of aloes, made with mint-water, a decoction of savin, savin-water, spring-water, the decoction of gentian, arum, sarsaparilla, and china; spirit of sal-armoniac, and of tartar, oil of caraway-seeds, Jones's panacea of opium, Sydenham's liquid laudanum, spirit of saffron, and of turpentine, *Tinctura martis tartariz.* Spirit of guaiacum, spirit of hartshorn, and the oils of turpentine, guaiacum, lavender, and cloves. He further found, that a decoction of the Peruvian bark rendered the serum much more fluid than any of these liquors; that spirit of wine, with camphire, strongly coagulated it; and that after they had, for some time, remain'd together in the vial, there was a large sediment at the bottom; the upper part of the liquor appearing clear and transparent; that rectified spirit of wine kept it turbid, without any precipitation; that the tinctures of scammony, castor, amber, sulphur, and Peruvian bark, moderately coagulated the serum; that the tinctures of saffron, and of metals, the *Porestates*

*succini*, and *Sal. vol. oleos.* afforded a light coagulum, and the *Tinct. mart. Myrsic.* a strong one; a concreted mass, like gum, falling to the bottom; that the diaphoretic tincture of antimony render'd it turbid, and a little concreted; that the tinctures of jalap, and of amber, with sal-armoniac, render'd it only turbid; and, lastly, that the tinctures of *Spec. diamb.* and cochineal, made with spirit of wine, afforded scarce any coagulum. See *Freind. Emmenolog.* p. 162, 163.

The decoctions of pomegranat-shells, tormentil, and bistort, being severally put to some serum of human blood, caus'd it to concrete a little. Tincture of coral coagulated it. Spirit of salt concreted a small part of it; but left the other thin and liquid. Spirit of nitre made a strong coagulum; but half the serum remain'd fluid. The same happened with *Spir. nitri bezoartic.* Oil of vitriol precipitated a coagulum; leaving some part liquid. The *Tinct. antiphthisica* made it turbid, and somewhat concreted it. *Aqua fortis*, and *Spir. vitriol. philosoph.* gave a white coagulum. *Aqua styptica* made a very strong concretion. The tincture of *Terra Japon.* gave a red coagulum. A solution of salt, in common water, made a white concreted mass; as did, also, a like solution of nitre. *Emmenolog.* p. 177, 178.

## S E C T. III.

**H**AVING, for want of materials, been reduced to treat the history of human blood in so very imperfect a manner, as to leave many of the primary heads untouched, and others but slightly spoken to; I shall here, by way of specimen, branch one of the primary heads into its several parts, and treat of each distinctly. And since the spirit of human blood, is one of the noblest of urinous or volatile alkalies; so that most of the things that shall be taught concerning it, may, with some little variation, be applied to spirit of urine, hartshorn, sal-armoniack, foot, &c. I shall make choice of that; and give a kind of summary of the history of volatile salts, in general. But it will here be necessary to take notice, first, that the spirit I employed in making the following tryals and observations, was drawn from human blood, without any sand, clay, or other addition, except some vinous spirit to preserve it; and that the first distillations were performed in retorts plac'd in sand; care being taken that the vessels were not near filled: because blood, if it be not well dry'd, is apt to swell much, and pass into the neck of the retort, if not into the receiver. Secondly, that the blood we made use of, was drawn from persons who parted with it out of custom. And, lastly, that there being so great an affinity between the spirit and volatile salt of human blood, that, probably, the latter is little other than the spirit in a dry form, and the former than the salt united with phlegm enough to give it a liquid form; 'tis presumed, that it may be allowable to consider the volatile salt of blood as its dry spirit.

1. The several ways of distilling human blood.
2. Whether human blood may be so ordered, by fermentation or putrefaction, that, in distillation, a spirit, either urinous or vinous, may ascend before the phlegm. Subordinate heads for the history of the spirit of human blood.
3. Whether spirit of human blood be really any thing but the volatile salt and phlegm, well commixed.
4. The species of saline bodies, to which spirit of human blood is to be referr'd.
5. Whether spirit of human blood differs from spirit of urine, and other spirits that are called volatile alkalies.
6. The quantity of spirit contained in human blood; whether accompanied with its serum, or dried.
7. The specific gravity of spirit of human blood.
8. The odour, taste, colour, transparency, and consistence of the spirit of human blood.
9. The solutive power of the spirit of human blood.
10. The tinctures that may be drawn with spirit of human blood.
11. The coagulating power of the spirit of human blood.
12. The precipitating power of the spirit of human blood.
13. The



- MEDICINE. 13. The affinity between spirit of human blood, and some chymical oils and vinous spirits.
14. The relation between spirit of human blood and the air.
15. The hostility of spirit of human blood with acids, whether in the form of liquors, or of fumes.
16. The medicinal virtues of spirit of human blood, outwardly applied.
17. The medicinal virtues of spirit of human blood, inwardly used, in pleurisies, head-achs, coughs, fevers, the scurvy, cachexies, dropsies, fits of the mother, &c.
18. Particulars omitted, and promiscuous experiments, and observations, concerning the spirit of human blood.

The several  
ways of distill-  
ing human  
blood.

Observing that several bodies, when distill'd with quick-lime, afford liquors different from those they would have yielded, if they had been distill'd either *per se*, or with some vulgar addition, we took five ounces of concreted, but not dry'd human blood, and having mixed it with an equal weight of quick-lime, we distill'd it, by degrees of fire, in a retort plac'd in sand, and thereby obtain'd a large proportion of a reddish spirituous liquor, not considerably phlegmy, together with some oil, very small in quantity; the rest being probably kept back by the lime: and of this little oil, there was a small portion that sunk in the spirit; the rest swimming upon it.

The spirit, being put into a small head and body, was set in a digestive furnace to rectify, at leisure, with a very gentle heat, and the receiver was three or four times shifted, that we might observe what difference there would be betwixt the successive portions of liquor. The first that came over, did not smell near so rank as that distill'd *per se*. This observation belongs, also, to the three or four succeeding portions of liquor: probably, because the lime had better freed the spirit of the first distillation from the fetid oil; many of whose particles are apt imperceptibly to mix with it, when drawn over without addition. The rectified spirit, which was clear and colourless, had a taste much stronger than its smell; for a small drop of it upon the tongue, had something of a fieryness that was surprizing, and lasted longer than one would wish; which made me doubt, whether the spirituous part of the blood had not carried up with it, some of the fiery parts of the quick-lime: whence one wou'd expect some uncommon effects from such a spirit, which, in this case, would be enriched with a kind of volatalized alkali; a thing much desired by many chymists and physicians. Upon this suspicion, we dropt a little of it into a strong solution of sublimate, in fair water, when it seem'd, at the first contact, to make a precipitate a little enclining to yellow; tho' afterwards the precipitate appeared white, like that made with ordinary volatile liquors of an urinous nature.

But expecting that our alkaline spirit of blood, so I call it, would have some peculiar qualities, differing from the spirit, drawn without  
ad-

addition; I thought fit to make a few trials with it, whose event MEDICINE. justify'd my conjectures. For, having put some of it, well rectify'd, into a glass egg with a slender neck, it did not then afford any volatile salt in a dry form; (tho' afterwards, by another trial, we at length obtained a little) and having continued the trial somewhat obstinately, we found the spirit, by the action of the fire, to have become muddy.

Having mixed another portion of it with highly rectified ardent spirit, and kept them all night in the cold, no coagulation ensued; nor could we perceive any, after it had been kept, for several hours, in a moderate heat. But the mixture acquired a yellow colour, and let fall a pretty deal of darkish powder.

We put to another parcel of our spirit, some good spirit of salt; but tho' they smok'd much at their meeting, yet we observed no noise, nor bubbles, upon their mixture. And having united another portion with oil of vitriol; tho' there was produced a very great smoke, and an intense degree of heat, yet there was no visible ebullition, nor any noise, or bubbles produced, but the colour of the oil of vitriol was very much heightened; the mixture growing almost red.

From these and the like phenomena we may gather, that our alkalizate spirit of blood differs, in several particulars, from the simple; and may, probably, be very considerable, both as a medicine and a menstruum.

We took two ounces of tartar, calcined to whiteness by an equal weight of kindled nitre, and mingled this alkali with two ounces of dry'd human blood, in powder. This mixture being distilled in a retort, in a sand furnace, made it appear by its productions, that quick-lime, on these occasions, acts differently upon the blood from other alkalies. For the distillation wherein lime was employed, afforded us a spirit, that, before rectification, was very strong, and unaccompanied with dry salt; but the calcination of nitre and tartar, afforded us, at the very first distillation, a spirit less strong, but so much volatile salt as covered almost all the inside of the receiver; and tho' the strong saline spirit of blood, made with quick-lime, would not make an effervescence with acid spirits, yet this volatile salt readily did, upon the affusion of spirit of salt.

Besides the fixt alkaline addition, with which I distilled dry'd human blood, I added to it that very acid one, oil of vitriol; for I had found by trial, that this liquor being mixed with other bodies, particularly some belonging to the animal kingdom, did, in an odd manner, unite its own substance with them, and notably diversify the products of the distillation. We put, therefore, upon three ounces of powder'd human blood, an equal weight of oil of vitriol, and left them for some time together, to try if by the action of this corrosive menstruum, a heat would not be excited; and, accordingly, we found, that after a while, the mixture grew sensibly warm. Then we removed

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**MEDICINE.** the retort into a sand-furnace; and distilling by degrees of fire, we had a spirit which was preceded by a pretty deal of phlegmy liquor, of an odd sulphureous smell, but surprizingly strong and lasting. It seemed remarkable, that, notwithstanding the great acidity of oil of vitriol, and the fixing power it exercises on many bodies, wherewith it is committed to distillation, our experiment afforded us a considerable quantity of volatile matter, in the form of a white salt; but the smell and tast of it were very uncommon.

*Whether human blood may afford, by distillation, a spirit, urinous or vinous, before the phlegm.*

By what I have yet tried, I am not much encouraged to expect a vinous, or ardent spirit from human blood, tho' that be the usual product of fermentation in liquors; and the less, because I am not sure that there is any fermentation, truly and properly so called, in human blood, either within or out of the body; having never found any thing in the blood or urine, which convinced me, that either of them would afford an ardent spirit.

I once kept human blood for a year together, in a glass, hermetically closed, with a design to try, whether any spirits would first ascend; but when the blood came to be exposed to the air, the scent of it was so offensive, that we were obliged to have it hastily thrown away. Another time, having caused some sheeps blood to be digested, in a large vial hermetically sealed; after it had long continued in the digestive furnace, it, upon a sudden, broke with a surprizing noise, and blew off the long neck of the vial. Two or three like mischances I had, in attempts made on human blood. But this ill success did not hinder me from attempting something of the like kind; and looking upon the serum of the blood, as the likeliest part of it to concur to a proper fermentation, we put to some ounces of it, about a fourth part of raisins well bruised, and kept them in a glass, whereof a considerable part was left empty; and having closed the vessel, we set it in a warm room; and within a few days the raisins began to emerge, and afterwards continued to float; and there was produced a considerable quantity of permanent and springy air. Which phenomena seemed plainly to argue, that there had been some degree of fermentation produced in the mixture; yet when we came to distil the serum, thus alter'd, tho' it did not smell as if it had putrefied, yet the liquor that first ascended, even with a gentle heat, did not tast or smell like a vinous spirit; tho' it differed from meer phlegm. I, likewise, tried, with the serous part of the blood, whether it would by digestion, or putrefaction, be so opened, as, when distill'd, to let the spirit ascend before the phlegm; and having kept a quantity of this serum above four times as long as is sufficient to make urine, in distillation, part with its spirit before its phlegm, we distill'd it with a very gentle fire, that few or none besides the fugitive parts, might at first ascend. But we found the liquor that came over, to have but little strength, either as to smell or tast; nor did it readily turn syrup of violets green, tho' after some hours standing together,  
it



it would; yet as a volatile alkali, it presently turned a strong solution, made of common sublimate in fair water, into a white, opaque, and almost milky liquor. MEDICINE.

What has hitherto occurred to me, inclines me to think, that the spirit of human blood is totally compos'd of volatile salt and phlegm, tho' not, perhaps, pure and unmixed; for when the spirit, volatile salt, and oil, are separated from it by distillation and sublimation, as far as is usual in chymical preparations of volatile alkalies, the remaining liquor, which passes for phlegm, will yet be impregnated with some particles of oil, and sometimes a few of volatile salt, that are too minute to be distinguishable by the naked eye. But whether frequent rectifications may so accurately separate these heterogeneous parts, as perfectly to free the aqueous ones from them, and thereby reduce the phlegm to simple, or elementary water, I leave undetermined. And the rather, because, by frequent distillations, some particles of the fire may, possibly, from time to time, substantially be associated with those of the liquor; and even in the first distillation of human blood, the fire may have either separated, or produced a liquor, that, tho' almost strengthless, and not justly referable to any of the received principles, or ingredients, oil, salt, and earth, is not yet phlegm, truly so call'd, but a neutral liquor, which woods, and many other bodies, afford by distillation, that is neither acid, nor alkalizate, nor true phlegm.

But as a composition may be discovered, perhaps better by producing, than by resolving it; we dissolved in distill'd water as much volatile salt of human blood, as the liquor would take up; and then having carefully distilled it in a conveniently shaped vessel, with a regulated degree of heat, the distillation afforded us a liquor, that, by its smell, taste, and operations, appeared to be a good brisk spirit of human blood. And this experiment was repeated with the like success.

'Tis well known, that of late, saline spirits obtained by distillation, have been observed to be of two sorts; the saline spirits that ascend in distillation, are some of them acid in taste; as spirit of nitre, spirit of vitriol, &c. and some have tastes like common salt, or like lixivate salts; but their difference is greater in their operations than their tastes; for being put together, there will presently ensue a manifest conflict between them, and usually the one will precipitate the bodies that the other hath dissolved. 'Tis necessary to add, that among the salts called alkalies, some are fix'd in considerable degrees of fire, and others not; for which reason many modern chymists and physicians, who take acid and alkali for the true principles of mix'd bodies, call the one fix'd, and the other volatile alkalies. And since the names fix'd alkalies, and volatile, are now much in request, I shall sometimes use them in the vulgar acceptation.

*Whether spirit of human blood be any thing but the volatile salt and phlegm united.*

*The species of saline bodies, to which this spirit is referable.*

## MEDICINE.

This being premis'd, I say, the spirit of human blood is to be referred to that species of saline bodies; because tho' the spirit of blood be a liquor, yet its more efficacious operations seem totally to depend upon the fugitive salt wherewith it abounds. We know, that some volatile salts, which rise even in a dry form, may not be of an alkalizate, but acid nature; and not only *Helmont* and his disciples, but a great part of the modern chymists and physicians, also, ascribe digestion to an acid ferment, or menstruum in the stomach; whence it should seem, that acid corpuscles may pass into the mass of blood, and impregnate it. But notwithstanding this, the spirit of human blood is manifestly referable to that class, which many call volatile alkalies (and I often term urinous spirits); for I find spirit of blood capable of effecting those things, the performance of which has been look'd on, almost ever since I propos'd them, as the touch-stone to know volatile alkalies, and distinguish them from the other sorts of saline bodies; for it will make a great conflict with acid spirits, as spirit of salt, *Aqua fortis*, &c. it immediately turns syrup of violets into a fair green; 'twill precipitate a solution of sublimate, in common water, into a white powder; and, in short, produce those other effects that may be expected from true volatile alkalies.

If, indeed, I were sure, digestion was performed by an acid ferment or juice, whencesoever the stomach is furnish'd with it, I should suspect that some acid particles may be mixed with the blood. But that would not hinder me from referring the spirit of human blood to volatile alkalies; because so few acid particles would be either destroy'd by the alkalizate ones, that so abound in the spirit; or at least these would be so very predominant, as might well allow us to give their denomination to the mixture. Thus, if a few drops of spirit of vinegar were mixed with some pints of stale urine, they would either be deprived of their acidity, by some corpuscles of a contrary nature, that they meet with in the liquor; or be so obscured and overpowered by the fugitive salts it abounds with, that the acid particles would not hinder the spirituous liquor, drawn from the mixture by distillation, to be justly referable to the class of volatile urinous salts.

Whether it differs from spirit of urine, and other volatile alkalies.

It seems hard to determine, whether there be any difference betwixt the spirit of human blood, and other volatile alkalies; because two bodies may agree in many qualities, and, perhaps, in all the most obvious; and yet on some third body, or in some cases, manifest distinct powers, and have their peculiar operations.

But there may be a great difference between volatile salts and spirits, as they are ordinarily prepared for medicinal uses, and as by repeated rectifications, and other ways of depuration, they may be brought to a greater simplicity or purity. And whether the spirit of human blood, and other liquors abounding, like it, in volatile alkalies, reduced to as great a purity, as they can, by art, be brought to, would be altogether alike in their nature and qualities, or no; yet,

yet, if we consider them in that state, wherein they are thought pure MEDICINE enough for medicinal uses, and, accordingly, are employed by physicians and chymists; there is, very probably, some difference between the spirit of human blood, and other volatile alkalies; and particularly those afforded by urine, and by hartshorn. For tho', to me, the bad smells of all these liquors, seem to be much alike, yet several ladies, and those of very different ages, affirm, they find a manifest difference between these smells, and abhor the odour of spirit of blood, tho' they will, with pleasure, long hold their noses over the spirit of hartshorn, and even that of sal-armoniac; and affirm themselves to be much refreshed by it. And tho' with spirit of urine, or sal-armoniac, joined in a due proportion with spirit of salt, I have usually been able to make a salt, that shoots into the peculiar figure of sal-armoniac; a figure very different from that of sea-salt, nitre, &c. yet I have seldom, if ever, obtained a salt of that shape, by the mixture of the spirit of human blood, with that of common salt; for tho' their saline corpuscles, upon the evaporation of the superfluous moisture, would coagulate together, yet the concretion seem'd confused; and either all, or a great part of it, was destitute of that neat and distinct shape, I had several times observed in concretions, made by the mixture of the spirit of sea-salt with urinous spirits. And as to the medicinal virtues of spirit of blood, *Helmont* tells us, there is a considerable difference between the spirit of human blood, and that of urine; since, according to him, the spirit of human blood cures epilepsies; a thing the spirit of urine will not do.

'Tis not easy to determine the exact proportion of that liquor, which, when by distillation obtained from human blood, the chymists call, its spirit, with regard to the other principles, or ingredients, whereof the blood consists. For some mens blood may be much more phlegmy or serous, than that of others; which it self may be more or less spirituous, according to the complexion, age, sex, &c. of the person. But twelve ounces of healthy human blood, afforded us seven ounces and an half of phlegm; and, consequently, about four ounces and an half of dry matter. And having committed to distillation, in a retort, and a sand furnace, seven ounces of well dry'd blood, we obtained about seven drams of spirit; to which, tho' it were not rectified, that name may well be given, because it was so very rich in spirituous and saline parts, that it left in the receiver, and in the containing vial, a large quantity of volatile salt undissolved; which a phlegmy liquor would not have done: and if spirit of blood be only salt and phlegm united, we may well suppose, that human blood yields a far greater proportion of spirit than this; since from the seven ounces of our dry'd blood, we obtained about five drams of volatile salt; which, if we had, by distillation, united with a fit quantity of phlegm, would, probably, have afforded us near two ounces more, of a liquor deserving the name of spirit.

*The quantity of spirit contained in human blood, accompanied with its serum, or dry'd.*



## MEDICINE.

*The consistence  
and specific  
gravity of the  
spirit of hu-  
man blood.*

I found that a compact body weighing fifty-eight grains, in the air, and in water six grains, and three fourths, weighed in rectified spirit of human blood but five grains, and one fourth. And notwithstanding the volatility of our spirit of blood, I found that a large piece of amber, being put into it, did not fall to the bottom of the liquor, but kept floating at the upper part of it; and if plung'd into it, would emerge.

One might expect a manifest degree of tenacity in the spirit of human blood, because, among many modern chymists, it passes for an alkali; and we know that several other alkalizate liquors, as oil of tartar per deliquium, fixed nitre resolv'd the same way, solution of potashes, &c. are sensibly unctuous, and but languidly fluid; yet I did not observe, that some rectified spirit of human blood, tried between my fingers, did feel more unctuous than common water. And as those who sell brandy, or spirit of wine, usually shake it, till it afford some froth, and then by the stay this makes on the surface, judge of the tenacity or tenuity of the liquor; esteeming that to be the most unctuous, whereon the bubbles make the longest stay, and *à contrà*; I thought fit, by the same method, to examine spirit of human blood; and found, that the froth would last very little on the surface of it; the bubbles breaking or vanishing, almost as suddenly as if the liquor had been good spirit of wine. I, likewise, observed, that when I warily let fall of our well rectified spirit of blood upon some other body, it seemed that the single drops were manifestly smaller than those of water, and of several other liquors, would have been.

*Its subtilty  
and activity.*

Because it may be of some importance, to know how subtile the active parts of spirit of human blood are, and how disposed or fitted to disperse or diffuse themselves through other liquors of convenient textures; we so prepared common water by infusions, made in it without heat, that by putting one single drop of our rectified spirit of human blood into four ounces, and four scruples of the prepared water, and lightly shaking the vial, there appeared through the liquor a manifest colour, whereof no degree at all was discernible in it just before: which sufficiently argues a wonderful subtilty of parts in the spirit we employ'd; since a single drop of it could disperse its corpuscles through, and unite with two thousand times as much water; and yet retain so much activity, as to make their presence not only sensible, but conspicuous, by a manifest change of colour which they produced. This computation, indeed, is made, upon supposition, that a drop of water weighs about a grain, and that a drop of our spirit of blood was of the same weight with a drop of water.

The former supposition is commonly made; and tho' I have not found it to be exactly true; (for a drop of water weighs more than a grain;) yet this difference is much more than recompensed by that we found between the weight of a drop of water, and the weight of one of spirit of human blood. For having, in a very good balance, let fall

fall ten drops of common water, and as many of our rectified spirit of MEDICINE. human blood, we found, as we might well expect, that a drop of the spirit, as it was manifestly less, so it was far lighter than a drop of water; whence the whole ten drops did not amount to four grains; so that we may safely judge the drop of spirit to have manifestly diffused it self, and acted upon above four thousand times so much water in weight, (and perhaps in bulk too;) since, indeed, the proportion extended a considerable way towards that of one to five thousand; and may, therefore, be said to be as that of one to between four and five thousand. And yet a considerable part of the single drop I employed was phlegm, useless to the change produced; the effect being wholly due to the saline spirit of the little single drop.

The spirit of human blood is, with regard to some liquors, potentially cold, since it refrigerates them; and in reference to others, potentially hot; since, being mix'd with them, the mixture becomes actually hot. *It's heat, and coldness.*

Into a slender cylindrical glass we put the lower part of an hermetically sealed thermometer, and into the same glass poured as much moderately strong spirit of blood, as would cover the ball of the thermometer; when, dropping on this liquor some good spirit of salt, there was produced a conflict, accompanied with noise, bubbles, and a heat, that suddenly made the spirit of wine ascend above two inches and a half. This experiment is the more considerable, because there are many volatile alkalies that, being confounded with acid spirits, tho' they seem to make a true effervescence, yet really produce a notable degree of coldness. And tho' I have, several times, found, that the spirit of verdigrease would, with volatile salt of sal-armoniac, or of urine, produce a seeming effervescence, but a real coldness; this spirit of verdigrease, being mix'd in the foresaid small cylindrical glass, with but moderately strong spirit of blood, did not only produce a hissing noise, and numerous bubbles, but an actual heat, whereby the spirit of wine in the thermometer was made quickly to ascend above an inch and a half; tho' the liquors employed amounted not, both together, to two spoonfuls.

Having into a wide-mouth'd glass put as much spirit of blood, as would more than cover the ball of a small seal'd weather-glass, and suffered this instrument to stay there a while, that the ambient liquor and the included might be reduced to the same temper, as to heat and cold; we poured on some spirit of verdigrease made *per se*, and observed, that tho' this spirit, with some other volatile saline liquors, had a very differing operation, yet working with our spirit of blood, with which it made a conflict and excited bubbles, there was produced in the mixture a degree of warmth, sensible on the outside of the glass; but it was much more sensible in the thermometer, the liquor whereof ascended to a considerable height above the former station,

MEDIC NE. towards which, when the conflict of the two liquors was over, it began, tho' slowly, to return.

Since several salts, both volatile and fixed, being powder'd and put into water, will, whilst they are dissolving, sensibly refrigerate it; and on the other side, since some very subtil spirit, actually cold, being put into cold water, will quickly produce in it a sensible warmth, I thought proper to try, what the spirit of human blood would do, when employ'd after the same manner. Having, therefore, placed a sealed thermometer in an open mouth'd glass, furnished with as much distill'd water as would cover the ball of the instrument, we left it there for a while, to bring the internal liquor and the external to the same degree of coldness: then we poured upon the immersed ball two or three spoonfuls of spirit of human blood, but perceived no alteration in the thermometer, unless the spirit of wine in the stem subsided a very little.

*Its solutive  
power, and  
balsamic vir-  
tue.*

We took crude copper, in filings, and having poured on it some highly rectified spirit of human blood, we shook them together, and in about a quarter of an hour, or less, perceived the menstruum to look a little bluish; and this colour grew gradually higher, till after some hours the menstruum had dissolved copper enough to make it deeply blue. In some circumstances the spirit of blood has a surprizingly sudden operation upon copper. For having made a coined piece of that metal clean and bright, and put a drop or two of our spirit upon it; within about half a minute, the verge of the moistened part of the surface appeared bluish, and presently after, the rest of the wetted part acquired a fine azure colour.

We also took filings of zink, or spelter, and having poured on them very well rectified spirit of blood, we observed, that, even in the cold, it quickly began to work manifestly, tho' not vigorously thereon. But being assisted with a little heat, it dissolved the zink briskly, and not without producing numerous bubbles.

I took a piece of coagulated blood, but not dry'd, somewhat bigger than a large pea, and cut from the lower part of the lump, that it might be black. This clot we put into a slender vial of clear glass, that the colour might the better be discerned, and then poured upon it a little rectified spirit of human blood, and shook the glass a little; whereupon the colour of, at least, the superficial part of the blood, was, in an instant, manifestly changed; the blackness quite disappearing, and being succeeded by a very florid colour, like that of fine scarlet. The liquor, also, was tinged, but not with near so deep or so fair a red; and by the little bubbles, which, from time to time, past out of the clot, it seemed to work somewhat like a menstruum. Yet soon after, coming to look upon this lump of blood again, I found it to have much degenerated from its natural colour, to one less fair and more dark.

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We took also another clot of blood, like the former, only one part of it, which had lain next the air, was not black; and having, in a vial like the former, poured on it some spirit of blood, taken out of the same vial, whence I took the first parcel, the reddish colour seemed presently to be much improved, and made more fair, and like true scarlet. But the black was not abolished, but changed dark and dirty.

Twelve drams of human blood were put up into a bolt-head, with two drams of spirit of human blood; and after they had stood together for above twelve months, they appeared, through the glass, of a fine florid colour, and seemed to be little less than totally fluid. And, indeed, when we came to open the vessel, which was carefully stopp'd with a good cork, and hard sealing wax, we found no ill scent, or other sign of putrefaction in the mixture, and but a very small portion of blood lightly clotted at the bottom; so that the spirit of human blood seems to have a great embalming virtue; since it was able for so long and so well to preserve six times its weight, of a body so apt to concrete and putrefie, as human blood is known to be; and, probably, would have preserved it much longer, if we had thought fit to prosecute the experiment. Upon distilling this mixture with a very gentle heat, the first liquor that ascended was not a spirit, but a kind of phlegm; tho' afterwards there came up, besides a spirituous liquor, a volatile salt, in a dry form.

We took a clot of human blood, of the bigness of a bean, and having put it into a vial, so that the part which before was contiguous to the air, was now the undermost; and the other, which was blackish, lay now the uppermost; we immediately poured upon it as much spirit of human blood, as was more than sufficient to cover it; and perceived, that the contact thereof presently began to lessen the blackness of the surface of the blood, and bring it to a considerable degree of floridness: and to try whether that would continue, we stopp'd the vial, and set it by till next morning, when looking upon it, we found the superficial colour not to be black, but still red.

Upon the powder of dry'd human blood, we put, in a small vial, some of the rectified spirit of human blood, which quickly dissolved part of it, and acquired a deep and pleasant colour: but highly rectified spirit of wine being put upon some of the same powder, in a like glass, did not in many hours acquire any manifest tincture; and got but a pale yellow one, even after having been for a longer time kept in a moderate heat: yet common water being put upon another portion of the same powder, quickly appeared, by the colour it acquired, to have dissolv'd a pretty deal of it.

Some of our spirit of human blood, being put upon two parcels of curious vitriol, that I had as a rarity from the *East-Indies*, one whereof was in lumps, and the other beaten to powder; the liquor being able to dissolve the former but slowly, made little or no froth; but the spirit upon the latter working hastily, produced a manifest one. And

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**MEDICINE.** the solutions made of both parcels, were of a deeper and more lovely blue, than the mineral it self. Nor did I observe in them any precipitate of a dark colour, as I have done upon the mixture of spirit of urine, and ordinary vitriol.

On fresh filings of iron, we poured some of our spirit, and having kept them a while together in digestion, we found that the liquor had wrought on the metal, and produced a considerable quantity of a light substance, in colour almost like the *Crocus*, but something paler. There also appeared in the liquor many thin plates, like a kind of *Terra foliata*, which after a very slight agitation, being held against the sun-beams, exhibited the colours of the rain-bow, in a very vivid and surprizing manner: but I did not perceive that the tast of the liquor was considerable ferruginous.

Having with a clean pen drawn some letters upon white paper, with spirit of human blood, and, as soon as 'twas dry, mov'd the unwritten side over the flame of a candle; we found that this liquor may be employ'd as an invisible ink; and it seemed to be somewhat better than those afforded by serum and urine.

*What tinctures may be drawn with spirit of human blood.*

Spirit of blood being put upon *English* saffron, soon acquired a fine yellow colour.

The same put upon powder'd turmeric, did, in the cold, extract from it a lovely tincture, like a rich solution of gold; which, probably, may prove a good deobstruent medicine, particularly in the jaundice.

Upon fine powder of human blood, we put some moderately strong spirit of the same subject, on which the liquor began very soon to colour it self, even in the cold; and within no long time after, appeared as red as ordinary *French* claret. This extract made me suspect, that the phlegm, which was not carefully separated from the spirit I then employed, might hasten the colouration of the menstruum. For which reason, I put upon another portion of the same powder, some rectified spirit of blood, so well dephlegmed, that it would not dissolve a grain of the volatile salt of blood; and found that this menstruum did not any thing near so soon draw a tincture, as the other had done; for after several hours, the colour it had obtained was but brown; tho', after some hours more, the colour appeared to be heighten'd into a redness; yet manifestly inferiour to that of the phlegmy spirit, whereto it did, however, in a longer time grow almost equal. By this means we may not only disguise the spirit of blood, but impregnate it with the finer parts of the unanalyzed solid body, which may, possibly, make the spirit a remedy more proper for some diseases, or constitutions: and this medicine I sometimes call the entire tincture of human blood.

But to shew that the spirit of human blood may extract tinctures out of some of the hardest bodies, I made the following experiment.

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We took some choice filings of steel, and having put them into a small glass-egg, we poured on them some highly rectified spirit of blood, and kept them all night in digestion with a moderate heat. The next day we found the menstruum turn'd of a deep brownish red colour; and some of the filings, that chanced to stick to the sides of the glass, seemed to have been, either by exhalations from the menstruum, or, perhaps, by the transient contact of it, as it was pouring in, turn'd into a kind of yellow *Crocus martis*. Having kept the menstruum and the filings together, in the same egg, for some days longer, the colour was grown opaque, and appeared to be black, when viewed in any considerable bulk: but it had another appearance, when thin spread upon white paper.

Suspecting that our spirit would work upon steel, in another manner than common acid solvents, we poured some of the tincture, drawn from filings of steel, upon a fresh tincture of galls in common water, but did not find that this liquor would, with the infusion, make any inky mixture; nor that the precipitate, which was quickly produced, was of a black, much less of a true inky colour.

I put some spirit of human blood upon fine powder'd amber, and kept them in digestion for some days, giving a moderate degree of heat; but we obtained not any considerable tincture: perhaps the spirit was not yet highly enough rectified, or the amber not so proper to yield its tincture, as I have several times found the courser and deeper coloured sort to be.

Having put some spirit of human blood upon seed-lac, tho' this be a resinous gum, and of no easy solution, the spirit soon became tinged, as I expected, because I conjectured, that the redness apparent in many of these grains, is but superficial, and proceeds from some adhering blood of the little insects, that by their biting occasion the production of this gum, upon the twigs of the tree where the lac is found. So that the tincture seems not to be drawn from the lac it self, but rather to be afforded from the blood of these little animals, which the spirit of human blood, that will draw tinctures from dry'd man's blood, dissolves: and this tincture may, probably, be a good medicine; since most of the insects used in physic, as millepedes, bees, &c. even in our colder climates, afford remedies of very subtile and piercing parts, and of considerable efficacy.

I have found, by trial purposely made, that the highly rectified spirit of human blood, being well mixed, by shaking, with at least an equal part of vinous spirits, which wou'd burn all away, there will presently ensue a coagulation or concretion, either of the whole mixture, or a great portion of it, into corpuscles of a saline form, that cohering loosely together, make up a consistent mass, tho' very soft: and in this form it may remain, as far as I have yet try'd, for, perhaps, several months, or weeks at least, if it be kept in a cool place.

*The coagulating power of it.*



## MEDICINE.

~~~~~ In a frosty season we exposed, late at night, two or three spoons full of spirit of human blood, being but moderately strong; and tho' the cold of that season had thoroughly frozen a vial almost full of oil of vitriol; and the night wherein our spirit was exposed, was moderately frosty, yet the next morning we did not find so much as any superficial ice upon it: but having removed the vial into a mixture of powder'd ice, and common salt, we found, in no very long time, that most part of the spirit was turned into thin plates of ice, which join'd close together, and had their edges upwards, like those of the leaves of a book, when held with its back downwards.

Its precipitating power.

Of the precipitating power of spirit of human blood, I have yet observed nothing peculiar; but, as far as I have had occasion to try, it has, in common with those other volatile spirits which I call urinous, a power of precipitating most bodies that are dissolved in acid menstruums.

I have made trial upon red-lead, dissolved in the acid salt of vinegar, silver in *Aqua fortis*, gold in *Aqua regia*, and tin in an appropriated menstruum. I, also, with our spirit, precipitated the solutions of several other bodies; and, particularly, out of a solution of common salt, made in common water, we could readily precipitate with the spirit of blood, a substance that looked like a white earth: and such a substance I obtained, in far greater quantity, from that which the salt-makers call bittern; which usually remains in their salt-pans, after they have taken out as much as would coagulate in figured grains.

The spirit of human blood in part precipitates *Dantzick* vitriol dissolved in water.

We attempted to make *Aurum fulminans*, by precipitating a solution of gold, made in *Aqua regia*, with spirit of human blood; by dulcifying the precipitate with common water, and then drying it leisurely; and succeeded in the attempt.

The affinity between spirit of human blood, some chymical oils, and vinous spirits.

There seems, in the popular sense of the word, to be an affinity between rectified spirit of human blood, and pure spirit of wine; since we have observed, that, being put together, they will readily coagulate, and continue united for a long time. And, it is very probable, that the like association may be, also, made with other ardent spirits, prepared by fermentation.

We have, likewise, formerly noted, that our spirit will make a solution of the finer parts of human blood well dry'd; which seems to be the effect of some affinity or congruity between the spirit and the body it works on; because a highly rectified vinous spirit would not, that I could see, draw any tincture from it.

With lixivate liquors, such as are made of salt of tartar, fixed nitre, &c. resolv'd in the air, or otherwise, the chymists will expect, that the spirit of blood should have an affinity; since they esteem all these liquors alkalies; tho' this be volatile, and those be fixed. But tho' these liquors comport well with one another, yet we find not that

that they strictly associate by coagulation, as the spirit of blood does with spirit of wine. MEDICINE.

The same spirit of blood readily mingles with that spirit of vegetables, that I call adiaphorous; which argues, that there is some affinity between them, or rather, that there is not any manifest hostility, or contrariety.

The like relation may be found between spirit of blood, and many other liquors; but tho' there is, manifestly, a near relation between the spirit of human blood and the oil; since they both proceed immediately from the same body; yet even dephlegmed spirit of blood being shaken, and thereby confounded with its oil, will quickly separate again; tho' with spirit of wine (which is, according to the chymists, a liquid sulphur, as well as the oil) it will permanently unite, notwithstanding that these two liquors belong even to different kingdoms, the animal and the vegetable.

With the essential oils of aromatic vegetables, or, at least, with some of them, the well rectified spirit of human blood seems to have a greater affinity. For, having taken a dram of this liquor, and an equal weight of oil of aniseeds, drawn in an alembic, and shaken them well together, they made a soft, or semi-fluid white coagulum, which continued in that form for a day or two, and, probably, would have longer done so, if I had not proceeded further with it.

But suspecting, tho' spirit of blood would not totally mix with essential oils, it might either communicate some saline parts to, or work a change in them; I digested, for a while, in a glass with a long neck, some rectify'd spirit of human blood, and a convenient quantity of oil of aniseeds; and found, that the oil grew of a high yellow colour, and afterwards attained to a redness: which may, possibly, suggest a hint, as to the cause of some changes of colour, produced in some of the fluids of the body.

Upon the affinity, or congruity of the spirit of blood with that of wine, and with some essential oils, I founded a way of taking off the offensive smell of spirit of human blood; which is the only thing that is likely to keep the more delicate sort of patients from employing so useful a medicine: but till experience is duly consulted, I shall retain a doubt, whether the way employed to deprive our spirit of its ill scent, will not also deprive it of part of its efficacy. On the other side, it's probable, that these aromatiz'd spirits may, by being impregnated with many of the finer parts of the oils, employ'd to correct their odour, be likewise endowed with the virtues of those oils, which are liquors that seem to consist of the noblest parts of the vegetables that afford them.

To aromatize spirit of human blood, we employed two different ways; first, we took a convenient quantity of well rectify'd spirit of blood, and having put it into a glass-egg, we added to it as much, or half as much essential oil of aniseeds, for instance, and having

MEDICINE. Shaken these liquors together, to mix them very well, we plac'd the glafs, in a fit poſture, in a furnace where it ſhould not have too great a heat; by which means the ſlight texture of the coagulum being diſſolved, part of the oil appeared by it ſelf, floating at the top of the ſpirit; whence, being ſeparated, the remaining liquor was whitish and without any ill ſcent; the ſmell predominant in it being that of the aniſeeds, of which it taſted ſtrongly; tho' the ſaline ſpirituous parts of the blood in this liquor retain'd a conſiderable degree of their brisk and piercing taſt.

The other way we uſed to aromatize our ſpirit of blood, was, by employing a medium, to unite it with eſſential oils. For which purpoſe, in a vinous ſpirit, ſo dephlegmed, that in a ſilver ſpoon it would totally burn away, we diſſolved, by ſhaking, a convenient proportion of an eſſential oil; and to this ſolution added a convenient quantity of our rectified ſpirit of blood; and having, by ſhaking, mixed them as well as we could, we ſuffered the expected coagulum to reſt for ſome time; after which it appeared, that ſome of the oil was revived, and ſwam in drops diſtinct from the other liquor, which conſiſted of a mixture of the two ſpirits, impregnated with the particles of the oil they had intercepted and detained. This liquor abounded with little concretions, made by the coagulation of the ſanguineous and vinous ſpirit. And theſe, with a very gentle heat, ſublimed in the form of a volatile ſalt, to the upper part of the glaſs; which ſalt ſeemed to have a leſs penetrating odour, than the meer volatile ſalt of human blood; but had quite loſt its ill ſmell, as had, alſo, the remaining liquor; both being moderately imbued with that of the oil.

I thought it worth trying, whether there was any affinity between our ſpirit and the highly rectified oil of petroleum; and having ſhaken together a convenient quantity of each, in a new vial, they preſently turn'd into a white mixture. And tho', after it had, for many hours, been left to ſettle, the greater part of the oil ſwam above the ſpirit; yet there appeared, betwixt the two liquors, a large quantity of a whitish matter, which ſeem'd to be produced by the precipitation or union of many particles of the ſpirit and oil, more diſpoſed than the reſt to combine with one another.

*The relation
between ſpirit
of human blood
and the air.*

'Tis known that the contact of the air has a manifeſt operation upon extravafated blood, by changing its colour from black to a florid red, in that ſurface which is expoſed to it. We thinly ſpread, upon a piece of white paper, ſome ſmall filings of copper, and wetted them well, without covering them quite over, with a few drops of good ſpirit of blood; by which means, being very much expoſed to the free air, the action of the liquor was ſo much promoted, that within a minute or two it did, even in the cold, begin to acquire a bluish colour; and ſooner than one would have expected, that colour was ſo heightened as to become blue. But when I put another parcel of the ſame filings

filings into a vial, and covered them with spirit of blood, and then MEDICINE. stoppt the vial, to keep it from the external air, the liquor would not, in some hours, acquire so deep a colour.

Having, in a clear cylindrical vial, about an inch in diameter, put more filings of copper than were requisite to cover the bottom, we poured upon them so much spirit of human blood, as serv'd to swim a finger's breadth above them. This liquor, because of the quantity of air, contain'd in the vial, did, within few hours, acquire a rich blue colour, which, after a day or two, began to grow more faint, and continued to do so gradually till it almost vanished; yet the liquor was not altogether limpid, or colourless, as I have often had it with spirit of urine, or of sal-armoniac; which remains of bluishness I attribute to the great quantity of air, included in the vial, with so small a quantity of liquor. And tho' I thought it possible, that length of time might destroy these remains of bluishness also, yet, without waiting for that, I unstopt the vial, and perceived, in about two minutes, the surface of the liquor, where it was touch'd by the fresh air, became blue; and perhaps in less than a quarter of an hour, the whole body of the liquor had attained a deeper colour than that of the sky; which colour, the vial being seasonable and carefully stoppt, began in two or three days to grow paler again.

Into a slender cylindrical vial we put filings of copper, more than enough to cover the bottom, and then pouring on some spirit of human blood, till it reach'd about an inch above the filings, we stoppt the glass close; and, as we expected, the menstruum dissolved some of the metal, and acquired upon it a deep blue colour, which, by keeping the vessel in a quiet place, for some days, by degrees disappeared, and left the liquor like water. And then the glass being unstopt, there appeared a fine blue surface between the confines of the air and the liquor, in a minute or less; and this fine colour, extending it self downwards, was, in no long time, diffused through the whole body of the liquor; and that so plentifully, as to render it almost opaque. But tho' I kept the glass, for many days after, well stoppt, yet the colour did not disappear, as was expected, but continued very intense.

And having poured some of our spirit upon well powdered *Lap. Armenus*, the liquor did, even in the cold, and in no long time, acquire a deep and lovely blue, almost like the solution of filings of crude copper, made with the same menstruum.

I also made the like experiments succeed, with other spirits abounding in volatile salts; and, indeed, I found, by a careful tryal, that by means of a volatile spirit, made without any substance afforded from the body of man, I could, with filings of copper, make an experiment very like the preceeding; tho' in this the repeated contact of the air produc'd in the liquor not a blue, but a green colour.

Spirit of vinegar being put upon the florid superficies of a parcel of human blood, very quickly deprived it of its fresh scarlet colour; and made it of a dark or dirty one. The

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The juice of a lemmon squeezed upon the florid surface of blood, presently impair'd the colour; but did not appear to alter it any thing near so much as the spirit of vinegar.

Juice of oranges chang'd the colour of the florid surface of blood, less than juice of lemmons.

The black or lower part of a portion of human blood, being turn'd uppermost, and thereby exposed to the air, within three quarters of an hour, acquired by the contact of it, a pleasant and florid colour.

But if upon the black surface of the blood some good urinous spirit were dropt, an alteration would immediately be made; and a pleasant red colour presently appear on the surface of the blood.

Fixt alkalies, or lixivate salts, resolv'd *per deliquium*, likewise alter'd the black superficies of the blood to a red colour; but not so florid or pleasant as that produc'd by the urinous spirit. The fresh juice of the leaves of scurvy-grass being drop'd upon the black superficies of a lump of human blood, seem'd presently to make some change in the colour of it, which we judged to be somewhat reddish, inclinable to florid.

Having, in an unstopt glass, put some spirit of human blood into a receiver, placed upon our pneumatic engine, and withdrawn the incumbent air by pumping; the spirit of blood seem'd to afford less and fewer aerial bubbles, than such a quantity of common water it self would, probably, have done.

Having unexpectedly found a vial, that was written upon above twelve years before, and inscribed spirit of human blood, it appear'd to have been very loosely stop'd; yet not so, as to give cause to think the liquor was much wasted. But it had acquired a deep colour, almost like that of red wine, and was so dispirited and strengthless, that it appeared to be very little other than nauseous phlegm. Hence we may guess, how little a portion of the noble and genuine spirit, or salt, may suffice to make a liquor pass for spirit of human blood.

The hostility of this spirit with acids, in the form of liquors and fumes.

That there is in the spirit of human blood such a thing as a chymist, or a vulgar philosopher, would call hostility, or an antipathy to acids, has been plainly intimated already. I now add, that our spirit exercises this hostility against more than one sort of acid spirits; tho' perhaps they differ widely from one another; as spirit of salt, spirit of nitre, spirit and oil of vitriol, *Aqua fortis*, *Aqua regia*, &c. and even against natural acids too; as I found by the conflict it would make with fresh juice of lemmons, which it would put into a confused agitation, accompany'd with bubbles. And this was yet the more evident, when I employed the volatile salt of blood; that is, the spirit in a dry form: for having squeez'd upon a parcel of this, some juice of lemmons, there was presently excited a great commotion, accompany'd not only with froth but noise. Nay, further, this hostility extends even to the invisible effluvia of liquors, as appears by putting any strong acid spirit, as of salt, or of nitre, &c. into a wide-mouth'd

vial,

vial, and some well dephlegmed spirit of blood into another; for when I purposely inclined these glasses so towards each other, that their lips almost touched, and their respective liquors were ready to run out; tho' neither of the liquors did at all emit visible fumes, whilst they were kept asunder, with their glasses unstopp'd; yet now the fumes, meeting in the air, would make little coalitions, visible in the form of ascending smoke: and this production of smoke would long continue, if the vials were still held near together.

We took some pure volatile salt of human blood, and having just satiated it with spirit of nitre, we slowly evaporated the superfluous moisture, that the acid and urinous salts might be united into a dry concretion; from which my design was to separate them again; the salt of blood in its pristine form, and the spirit of nitre in the form of salt-petre. To effect this, we put the compound salt into a small bolt-head, with a long slender neck; and then added to it a convenient quantity of salt of tartar, and as much distilled water, as sufficed to make the mixture somewhat liquid; to promote the action of the contrary salts upon one another. By these mutual actions we suppos'd, that the saline spirits of nitre, being more agreeable to the fixed salt than to the volatile, would forsake the salt of blood, and suffer it to sublime; and, accordingly, having kept the glass, wherein the mixture was made, for a competent time in a convenient heat, a large proportion of fine volatile salt ascended in a dry form into the neck.

Having put to some of the spirit of human blood, a small quantity of exceeding strong spirit of nitre, there was, upon the conflict of the two liquors, excited so great a quantity of thick white fumes, that I could not but wonder at it; having never seen any thing of that kind comparable to it. And these fumes circulating long in the cavity of the glass, whereof, perhaps, a tenth part was full of liquor, did, many of them, tho' the vessel were wide-mouthed, fall back and run down the sides of the glass into the stagnant mixture, as if they had compos'd streams of a milky liquor. And when, at length, after these fumes had disappeared, we dropt in a little more of the same smoaking spirit of nitre, the like strange plenty of white exhalations presently ensued, and continued to circulate for a great while in the open glass; the mixture in the mean time appearing reddish. Being settled, and seeming to have been so discoloured by a fattish substance, we put to it a little rain, or distill'd water; and having by filtration separated it from the feces, and slowly evaporated the liquor thus clarified, the saline parts shot into crystals much of the shape, and crossing one another after the manner of *Stria* of salt-petre; but their colour, after a while, appeared yellow, as if some oily substance were yet mixed with them.

And tho', on several occasions, the spirit of blood appeared oily, yet I once had some distill'd from another parcel of blood, which, after having

MEDICINE. having been kept for a year, was limpid and colourless, like an ordinary vegetable spirit.

Some of the fore-mentioned crystals being put upon well kindled charcoals, presently melted, and burnt away with a noise like that of salt-petre; but the flame seemed not quite so flatulent, and differed in colour; being not at all blue, but very yellow. After the deflagration was quite over, I found an odd fixt substance left upon the coals; for it was not of a light colour, nor of an incoherent body like ashes, but a little lump of a brittle, dirty-coloured matter, in which I could not perceive an alkalizate tast, and, indeed, scarce any at all. And this substance being held in the flame, became red-hot, without appearing destroyed, no more than afterwards it did, by being long kept upon a glowing coal.

Having, by degrees, mixed our spirit of blood, with as much good spirit of nitre as it wou'd manifestly work on, there were, with noise, produced numerous bubbles; and being kept in a quiet place, till after the liquors had quite ceased to work on one another, it began to appear, that notwithstanding all our care to free the spirit of blood from oil, something oleaginous, that had been concealed in it, was partly separated by this operation; since not only a reddish colour was produced by it, but after a while the surface of the liquor was covered with a film; such as I have often observed in saline liquors greatly impregnated with antimony, or other sulphureous bodies. And this thin membrane had its superficies so dispos'd, that looking upon it with the eye placed conveniently, it appear'd adorn'd with vivid colours of the rain-bow; and in the same order they are seen in the clouds.

The medicinal
virtues of spi-
rit of human
blood, exter-
nally apply'd.

As far as I have observed, we do not regularly meet with any acid substance (unless we except the *Succus pancreaticus*) in a sound human body; but the several parts of it, whether solid as bones, or liquid as blood, afford in distillation plenty of liquor, impregnated with volatile salt; whence I am induced to think, that the spirit of human blood, wherein such a salt abounds, and whereof it is the principal and predominant ingredient, may, probably, have notable operations upon the human body, and afford medicines of great efficacy in many diseases. And tho' against most of these it is to be internally given, yet there are some in which it may be successful, when but externally administred. For, since well rectified spirit of human blood abounds with very subtile particles, which, in point of tast, odour, diffusiveness, and penetrancy, much resemble those of strong spirits of urine, of hartshorn, and of sal-armoniac; we may, very probably, expect to find the same virtues in the spirit of blood, that experience has shewn belong to them.

I have scarce ever seen any medicine operate so suddenly in hysteric fits, as a well dephlegmed spirit of sal-armoniac; (which is, in effect, chiefly a spirit of urine; a liquor separated from blood) and this by being barely applied to the nostrils. And even in agonizing persons, where it could not recover them, it wou'd frequently, for the time, bring

bring them out of their swoons, and make them know and understand the assistants, and, perhaps, speak to them too; of which I could give instances. A patient of Dr. Willis's, being in an apoplectic fit, was, by the Dr. at his going out of town, committed to the care of a very ingenious physician, who complain'd to me, that they could not hope for any success of their remedies; she being stupid, and having shut her mouth so close, that they could not get any thing down; upon which I gave him a very subtil spirit, either of sal-armoniac, or some other volatile and liquid alkali; by applying which to her nose, the physician found he could presently make her open her eyes, and, in part come to her self; but then she wou'd again, when the glass was removed, soon relapse. But having by those frequent vicissitudes, gained some time, and got a medicine for his purpose, he then held the glass to her nose long together; by which means she so recover'd her senses, that she was prevail'd upon to take the medicine; and tho', afterwards, upon removal of the vial, she returned into a senseless state, yet by the help of the urinous spirit, they kept her alive, till the medicine she had taken began to act, and make a large evacuation; which roused her, and, by degrees, relieved her. But in such difficult and desperate cases, I am not content that a vial, with a long neck, be held to the nose, but sometimes order, that little pellets of lint, or cotton, be dipt into the spirit, and thrust up the nostrils; the same thing I would advise, if need should require it, in the administration of spirit of human blood. And as, for external uses, I make a particular preparation of spirit of sal-armoniac, or of urine, that is more strong and piercing than that prepared in the more ordinary way; so to improve our spirit of blood, we put to some dry'd volatile salt of human blood, as much spirit of nitre as wou'd just serve to satiate it; and then, by evaporation, obtained an anomalous kind of compound salt, which afterwards, because we desired a medicine in a dry form, we sublimed from an equal weight of salt of tartar; a body fit to retain not only the phlegmy parts, but the oleaginous too, that often lie conceal'd in volatile salts and liquors, wherein they do not at first appear, and to which the greatest part of their fetid or offensive smell, may, probably, be imputed: by this means we obtained a dry white salt, of a very piercing scent. And to bring over the saline part of blood, in a liquid form, which, for the use of smelling, I commonly prefer to the dry; we mixed two parts of dry'd human blood, with three of lime, and then distill'd them with a strong fire; whereby we obtained much spirit, unaccompanied with any volatile salt in a dry form; which spirit seem'd, even without rectification, to have a stronger smell, and a more fiery taste, than other spirit of blood, after rectification. And if we had taken more, or stronger lime, we should, probably, have had less oil, and a more piercing spirit; since the lime wou'd, probably, have retained most of the oil, and, perhaps, all the superfluous moisture.

MEDICINE.

I have, likewise, often found, that slight head-aches have been cured in less than a quarter of an hour, by the bare smell of some of these well depurated volatile alkalies; and have been particularly relieved by that of human blood; very rarely, for these many years, using any other medicine, to free my self from pains of the head. And even violent and durable pains of that part have been, if not quite removed, yet much lessen'd by the same remedy often repeated; which I have, likewise, observed to be usually very effectual in faintings, especially those of hysterical women, and hypochondriacal men: whence our spirit of human blood, which is a liquor that in many qualities manifestly resembles other volatile alkalies, and which, when well freed from its oil, can scarce be distinguish'd from other urinous spirits, may, by its odour, be available in the like distempers. But for the more delicate patients, the offensive odour of our spirit may be greatly lessened by long digestions, or by repeated, or skilful rectifications, with the addition of high rectified spirit of wine, or chymical oils. Thus, a very few drops of true oil of rhodium will, as I have tried, make an ounce of spirit of wine so fragrant, that this solution being shaken together with a convenient quantity of well rectified spirit of human blood, there will a mixture be made, that I found to have a brisk scent; and yet to be finely imbued with the odoriferous particles of the rhodium.

Thus, also, the high tincture of amber, taken with spirit of wine, may be employed to correct the odour, and increase the virtues of spirit of human blood. But because it requires some skill, and much time, to draw this tincture from crude amber, tho' finely powder'd; I used the following quick and easy way, to draw a strong tincture from the oil it self: for tho' this oil will not, even by long shaking, thoroughly dissolve in spirit of wine, yet I found, that by well shaking those two liquors together, and leaving them to settle at leisure, tho' they would separate into distinct masses, yet the spirit of wine, even in the cold, extracted from the oil a fine tincture, of a high yellow colour, little different from that of the oil it self. Of this tincture I afterwards mixed as much with spirit of blood, as sufficed to obscure the urinous smell, and make that of the oil of amber somewhat predominant; and, as we judged, more subtile and brisk than it was before.

But, besides these medicinal uses, that may be made of the odours of spirit of blood, simple or compounded, it may have considerable virtues, apply'd in substance as a liquor, by way of fomentation, or otherwise. Thus the spirit of sal-armoniac has been much commended, for mitigating the sharp pains of the gout; and is said to have been successfully us'd in the erysipelas. And as our liquor is very spirituous and penetrating, and therefore proper to strengthen and resolve, and also of an alkalizate nature, which fits it to mortifie acidities; it seems very probable, that by virtue of these, and other benign qualities,

lities, it may, by being apply'd in its liquid form, prove serviceable in many cases, where the chirurgion's, or physician's help is required. MEDICINE.

As one kind of morbid matter may produce various distempers, so a single remedy, by being able to oppose one or two of the principal species of morbid matter, may cure different diseases; especially if it be endowed with any variety of active virtues. And, upon this ground, I am apt to think, that the spirit of human blood, skilfully prepared and administered, may be a good remedy in many internal disorders of the human body. And, indeed, volatile alkalies, in general, have been in *England* so successfully used in physic, of late, that I see small cause to doubt, that they will hereafter be more universally esteemed and employed; and gradually invite physicians to prefer them to many vulgar remedies, that, for want of better, are yet in common use; tho' they clog or weaken the patient, and want many advantageous qualities that may be found in volatile alkalies. The spirit of human blood, in particular, is endowed with various qualities, that are both active and medicinal; it mortifies acid salts, which are the causes of several diseases, and, if I mistake not, of some that are not usually imputed to them. It is a great resolver, and, therefore, fit to open obstructions, that produce many diseases; it is diaphoretic and diuretic, and on both these accounts assists nature to discharge several noxious salts, and expel many contagious, or malignant corpuscles, that offend her. It resists putrefaction, and coagulation of the blood, gives it a briskness and spirituousity, that promotes a free circulation; by which means it becomes a good cordial, and, probably, an antidote against some poisons. It is, also, very friendly to the *Genus nervosum*; and upon that account is likely to be very proper in hysteric cases, convulsions, some sort of head-aches, palsies, slight apoplexies, some kinds of asthma's, &c. It is also balsamic, in some circumstances, and may have many other virtues hitherto unobserved: for a medicine that does not weaken, nor cause great evacuations, nor clog the stomach, nor is blemished with the excess of any manifest quality; but has in it self a complex of so many useful powers, may reasonably be supposed available in abundance of diseases; so that a large part of those whereto human bodies are liable, may be powerfully opposed by some of those excellent qualities, which meet in the spirit of human blood.

A young lady, in whose family the consumption was an hereditary disease, was molested with a violent and stubborn cough, that was judged consumptive, and look'd upon by her physicians as incurable, without a seasonable remove from *London* into the *French* air; but she was already so far weakned, and there remained so much of the winter, that it was thought she would die before the proper season came for her to undertake so long a journey. On this occasion, being solicited by some friends of hers, to try what I could do to preserve her; I sent her some spirit of human blood, very carefully prepared and rectified; upon the use of which she manifestly mended, notwithstanding

The internal medicinal virtues thereof.

MEDICINE. standing the unfriendliness of the season; so that about the end of February, she grew able to venture for *Montpellier*; from whence, in autumn, she return'd recover'd. The same spirit of blood, made very pure and subtile, by the help of a lamp-furnace, was the medicine I put into the hands of an ingenious and successful physician, who complained to me, that a patient had quite puzzled him, and baffled the endeavours of other eminent men. This patient was frequently obnoxious to such violent and tormenting fits of the head-ach, that he could not endure the light; and was offended with almost every noise or motion that reach'd his ears; whence he was forc'd to give over his profession; but upon the constant use of the human spirit of human blood, he received such relief as made him, with great joy, return to the exercise of his trade. And the physician, to whom I gave the remedy for him, told me, that the patient having, by our famous *Harvey's* advice, been used to bleed once in two or three months, the physician counselled him, tho' recovered, not abruptly to break off his ancient custom; and the patient thereupon sent for the same chirurgeon who had formerly let him blood; but when this chirurgeon, who knew not what had been done to the patient, came to open a vein again, and perceived what kind of blood it afforded, he was so surprized, that he stopt the operation, and ask'd the man, with wonder, how he came by such florid blood, who used to have it so bad; adding, that 'twas pity to deprive him of so well condition'd a fluid.

The medicinal virtues hitherto mentioned, belong to the spirit of human blood, as 'tis pure and simple: but 'tis not improbable, that it may acquire other, and perhaps nobler faculties, if it be dexterously corrected, diversified, or united with fit ingredients; that is, in a word, skilfully altered or compounded. These things may be performed several ways: as, 1. By uniting, by long digestion, or frequent cohobations, the spirit of human blood, with the oils, salt, and phlegm of the same concrete, into a particular kind of mixture called *Clyffus*. 2. By uniting the spirit of blood with acids, as with spirit of nitre, spirit of vinegar, &c. and employing these mixtures, either in their liquid form, or reduc'd, by evaporation, into crystals or other salts; and making use of these, either as they are, or after a kind of analysis of them. 3. By uniting our spirit with metalline solutions, as of gold, silver, mercury; and with a solution of minium, made with spirit of vinegar, by the mixture of which liquor with spirit of blood, and a slow evaporation, I have had many finely figured crystals. 4. By dissolving in spirit of blood, carefully dephlegmed, sulphur open'd with salt of tartar: or by dissolving in it some metalline bodies, as copper, zink, and iron; the latter whereof will afford a liquor, very different from other preparations of steel usually made with acids; and may, probably, have some virtues distinct from those of the known remedies made of that metal.

But,

But, at once to correct, diversify, and compound our spirit, we may add to it, when we well rectified, an equal or double weight of rectified spirit of wine. For these liquors, being well shaken together, will, in great part, coagulate into salt, which, with a very gentle heat, will sublime in a dry form, wherein I found it to have lost almost all its offensive smell. And tho', against this way of proceeding it may be objected, that the efficacy of the medicine is, as well as the urinous smell, much weakened; yet I found this salt to retain a considerable degree of quickness and penetrancy. And that which our compounded salt leaves behind, if it be dephlegmed, may afford no despicable liquor, both for medical and mechanical uses.

And if the more simple way of altering the spirit of human blood be carried on a little further, by dissolving in the spirit of wine, before the conjunction of the two spirits be made, a convenient proportion, as perhaps a twenty-fourth part of an essential chymical oil; the volatile salt sublimed from this mixture, will not only be deprived of its ill smell, but endow'd with the scent and relish of the oil; which, by being thus united with a salt, very subtle and friendly to nature, will less over-power and offend the brain and stomach, than meer chymical oils; and being associated with such agile and penetrating corpuscles, may, with them, gain admission into the more inward recesses of the body, and there exercise the virtues belonging to the vegetables that afforded the oils, or at least to the oils themselves. In this odoriferous aromatic mixture, the oleaginous particles are, by the intervention of the saline ones, brought to unite readily with other liquors, and even with aqueous vehicles, and to continue long enough mixed for the patient to take them commodiously. And thus there may be a multitude of *Salia volatilium oleosa*, that is, of pleasing, subtle, and efficacious remedies for inward uses, prepared; even as many as the physician, or chymist, shall make essential oils. And if these be drawn from cephalic plants, as marjoram, rosemary, &c. or from cephalic spices, as nutmegs, cinnamon, &c. they will, probably, afford very brisk and grateful medicines, to relieve and comfort the brain and spirits, &c.

I recommend it to physicians to begin the natural histories of the other animal fluids, as the *saliva*, *lymphæ*, pancreatic juice, &c. Only having bestowed much pains upon urine; and thinking it a most noble subject to work upon; I shall here subjoin a set of titles, which I once drew up for the natural history of it.

1. The colours of human urine.
2. Its taste.
3. Its scent, fresh and putrified.
4. The heat and cold of human urine.
5. The specific gravity of human urine.
6. The consistence of it, as to density, viscosity, &c.

Head for
the natural
history of hu-
man urine es-
sential by me

MEDICINE.

7. The aerial particles contained in it.
8. Whether human urine is a fit liquor for fermentation, properly so call'd.
9. The difference between fresh and stale human urine.
10. The fermentation, or putrefaction, of human urine, and the time it requires.
11. The spontaneous separation of parts in human urine.
12. Its vulgar analysis, by distillation.
13. Some other ways of distilling human urine.
14. The proportion of the ingredients of human urine
15. The spirits of human urine.
16. The phlegm.
17. The volatile salt.
18. The fixt salt.
19. The compound salt.
20. The shining substances obtainable from human urine.
21. The salt predominant in human urine.
22. The empyreumatical oil, or oils of urine.
23. The mellago or rob of human urine, and its uses.
24. The terra damnata of human urine.
25. Some accidental differences of human urine, as 'tis emitted in the morning, at certain distances from meals, or after the use of certain aliments, or medicines, as sparagus, turpentine, &c. or at differing seasons of the year.
26. The affinity of human urine with other bodies, especially the vegetable and mineral.
27. The hostility of human urine with acids, &c.
28. The affinity and difference between urine, blood, gall, milk, &c. and other liquors, or animal juices; particularly the comparison between human urine and that of brutes.
29. The mechanical uses of human urine.
30. The chymical uses of human urine, and its parts, especially as menstruums.
31. The medicinal uses of human urine, external and internal.
32. Particulars omitted, relating to the history of human urine.
33. Promiscuous observations, experiments and inquiries about human urine.



MEMOIRS

FOR A

NATURAL HISTORY

O F

Mineral Waters.

S E C T. I.

THE search into the nature of mineral waters, being usually confined to very narrow limits; my present design is, to enlarge the knowledge of the subject, by proposing some comprehensive heads of enquiry about it.

The difficulty of determining the nature of mineral waters.

But I must own, that notwithstanding the several means I propose, of discovering the natures, or qualities, of such waters, the surest way of knowing them is, from a long experience of their good and bad effects; for, I question not, that there lie beneath the surface of the earth many mineral substances, some fixed, others volatile, some hard, some soft, some in the form of liquors, and others in that of fumes, to which the generality of learned men are wholly strangers; and the natures of such as have been rarely seen, are so little known, that no names are assign'd them: whence, of the ingredients we are unacquainted with, the proportions wherein they are mixed may be so numerous, and the qualities resulting therefrom so very different from those of the separate ingredients, that the difficulty of expressly determining the effects of mineral waters, *à priori*, seems almost insuperable to human understanding.

But this difficulty ought not to make us think, a project for the natural history of a mineral water useless. 'Tis no small advantage,

MEDICINE. to know what particulars are fit for our enquiry; to be furnished with a set of heads, under which particular experiments and observations may be ranged; and lastly, to be furnished with variety of methods to make the proper trials for investigating the nature, or examining the qualities of a water proposed: since the subject may hence be viewed on all its sides; and a conjecture be made, as to what saline, or other known minerals, and what quantities of them, impregnate the water; and, consequently, what effects 'tis likely to produce in human bodies.

*The necessity
there is for it.*

As to discover the nature of mineral waters, is a far more difficult task than those who have not tried wou'd imagine; we ought to view the subject in as many different lights as we can expose it to; and take in all the helps to the discovery we can; since a great many particulars that singly, or at the first view, seem not very pertinent, yet if survey'd in conjunction, and skilfully applied, may greatly conduce to the desired end. And I have here been the larger in my enquiries, because many observations have persuaded me, that physicians ought to consider very well the nature of the waters they prescribe; to what persons; for what diseases; and in what manner they employ them. For tho' many look upon these waters as such innocent medicines, that if they do no good, they can do no harm; yet the effects which have too often ensued upon the unskilful use of them, especially when long continued, shew the drinking of them to be no slight thing, that may safely be played with: for I have seen very great service, and very great mischief done thereby; and the latter, in particular, some time after their operation is thought to be over, and perhaps forgotten.

And I look upon the examination of the properties and qualities of mineral waters, as a thing of the greater importance, because I suspect, upon probable grounds, that by a diligent search there may be discovered, both in *England* and other countries, a far greater number of them than is yet imagined, especially ferruginous ones; for by some uncommon trials, I have found, that several minerals, which men either knew not what to make of, or by reason of their passing under other names, did not suspect to be chalybeate, abounded in parts of that nature. And as our globe is providentially furnished with a far greater plenty and variety of iron-ores and minerals, partaking of that metal, which is the most useful by far to mankind; so they are more dispos'd, than one wou'd expect from such hard bodies, to impregnate liquors, not manifestly acid, and that seem unlikely to work upon minerals much softer than they. To make this probable; upon the minute filings of pure steel, we put some tincture of galls made with common water, that had been filtr'd thro' cap-paper; and found, that in less than an hour, the transparent infusion of galls was alter'd to a dark, and almost inky colour, which it retained even after filtration; and this, tho' the vial that contained it was very slender. A like effect was produced by small filings of steel, but somewhat more slowly, in the red tincture of brazil, and also in that of log-wood made with common water.

In

In countries manifestly abounding with metalline and other minerals, it may, perhaps, be worth while to descend much lower than the superficies of the ground, to make search after subterranean springs and wells, and their operations upon human bodies. For I have been assured by those who had visited mines, that sometimes, at very great depths therein, they have found running, as well as stagnant water, of different tastes and qualities; and that the diggers, venturing to make use of them, discover'd some to be mischievous, and others innocent and medicinal. Of both these sorts we have instances in our tin-mines of *Cornwal*; and as to the latter, an ingenious gentleman, who has the over-sight of some *Cornish* water-works, tells me, that, in the bottom of a tin-work, called *Karnkey*, wrought above sixty fathoms deep, the mineral was a mixture of tin and iron, and the water red and thick, yet drank cool and pleasant, and pass'd by urine near as red as it was drank; "as I have been informed," says he, "by those who used it whilst the mine was working; but the vein of ore is now degenerated or lost."

SECT. II.

HE who wou'd draw up the history of a mineral water, to have its qualities examined or discover'd, shou'd, in my opinion, make three sorts of observations about it. And first, upon those particulars that relate to it, whilst yet under ground, or in its native receptacle; next upon its properties, and qualities, when drawn up at the spring-head, or other receptacle; and lastly, upon the operations and effects of it in the human body, both distemper'd and in health, according to the several methods and circumstances of its administration. To the first of these observations, the following heads are referable.

Heads for the natural history of a mineral water, considered in its channel or receptacle.

1. In what climate and parallel, or in what degree of latitude, the mineral water springs up, or stagnates.
2. Whether the spring-head, or other receptacle, chiefly regards the east, the west, the north, or the south.
3. Whether the water be found in a plain, or a valley; and if not, whether it rises in a hillock, a hill, or a mountain.
4. Whether it be found at the top, the middle, or the bottom of the rising ground.
5. Whether the water leaves any recrement, or unusual substance, upon the stones, or other bodies, that lie in the channels it passes through, or in the receptacles that contain it.
6. Whether there lie beneath, or near the medicinal water, any subterranean fire, that bath manifest chimneys, or vents, and visibly by night only, or by day, burns, or smoaks, either constantly, or at certain periods.

MEDICINE.

7. Whether at, or near the mouth of these vents, there be found either flowers of brimstone, a salt like sal-armoniac, or other mineral exhalations, in a dry form.

8. Whether there be under, or near the course, or channel of the water, any subterranean estuary, or latent mass of hot, or visibly burning materials: and whether such estuary afford an uniform heat, as to sense; or have hot fits, as it were periodically; and if so, whether these come at certain and stated times, or irregularly.

9. Whether over the estuary, or in some other part, near which the mineral water springs, there arise any visible mineral fumes, or smoke, early in the morning, or late in the evening; and if such fumes ascend, in what plenty, of what colour and scent.

10. What is the more obvious nature of that part of the soil, which appears not manifestly metalline, or marcasitical, and which the medicinal water passes through, or touches upon: and what are the qualities of the neighbouring soil, and the adjacent country; as whether it be rocky, stony, clayish, sandy, chalky, &c.

11. Whether there be any ores, marcasites, or earths, especially high-coloured ones, impregnated with mineral juices, to be met with in the course of the medicinal spring, or in the receptacle of the same water: and what these minerals are, whether copperish, ferruginous, marcasitical, &c. and whether the ores do, or do not abound in the metalline portion; as, also, with what other ingredient, as spar, sauke, sulphur, orpiment, arsenic, &c. they are mix'd or incorporated with.

12. Whether the spring of the medicinal water, was common water, before it came to any particular part of the soil it runs through, and there begins to be manifestly impregnated with mineral bodies.

13. And whether, in this case, it makes any effervescence, or other conflict, with the mineral it imbibes, or with any other water, or liquor, that it meets with in its way; and whether the conflict produce any heat or no.

14. Whether, if the mineral water be manifestly hot, or extraordinarily cold, the spring it flows out at, or the receptacle it stagnates in, have near it a well of water, of a contrary quality; as is observed in a few places of France, and elsewhere.

15. Whether, when the water appears in the spring, or receptacle, there float at the top, lie at the bottom, or swim between both, any drops, or considerable quantity of oil, like Naphta, or other bituminous, and inflammable substance.

16. Whether the water be considerably alter'd, in quantity or quality, by the different seasons of the year; by the varying temperatures of the air, as to heat, coldness, drought, &c. by the plenty or paucity, frequency or unfrequency of falling rains, or snows; and what may be the bounds, or measures of these alterations in the water.

The effects of rain upon a mineral spring. 'Tis known, that the drinking of ferruginous waters, such as the German-Spaw, and of Tunbridge, is usually prescribed for many weeks; during which time it often happens, that the fall of rains occasions a doubt, whether they be not so much diluted thereby, as to be spoil'd in their medicinal capacity: and, indeed, I more than once observed, that

that some such waters, after considerable rains, have lost their power of producing the usual colour with galls; and, therefore, it may, in some cases, prove very serviceable, to be able to conjecture, whether or no the rain has made the mineral water unfit for drinking. Now, a small rain does little or no harm to the medicinal spring; and sometimes, a moderate one, especially after a long drought, may, instead of weakening, increase its virtue, by washing down into its channel some salts, that, during the dry weather, were concentered in the pores of the ground; and, perhaps, also, by raising the water in the channel, so as to dissolve some salts concentered there, which it could not reach before. But if the rain has long continued, the estimate may best be made, partly by the greater or lesser depth of the spring, below the surface of the ground; but chiefly by the peculiar nature, or strength, of the mineral water. For, some springs are much more copiously impregnated than others; and therefore will bear a greater dilution by rain water. Thus, tho' I have found more than one of our *English* ferruginous springs, especially those near *London*, too much weakened by the water that rain'd into them; yet upon carefully trying, how much of that fluid some *German-Spa* water, which came very well conditioned to *London*, would bear, it appeared, that when this was diluted with no less than thrice its weight of rain-water, it still retained strength enough to produce a purplish colour, with fresh powder of galls.

17. Whether any thing, considerable, can be certainly discovered, or any very probable conjecture made, of the nature and qualities of the substances that impregnate the water, by a chymical and mechanical examination of the mineral earths, through which it flows, or in which it stagnates; and, particularly, from observing their colour, whether native, or acquired, by being kept in the fire; their specific gravity; their affording, or not affording any salt, or other soluble substance, by decoction; their being soluble, or indissoluble, in particular chymical menstrua of several sorts, as *Aqua fortis*, spirit of salt, &c. and their being committed to distillation, in vessels of different sorts, and various degrees of fire, with care to receive, separately, the different substances they afford, whether in the form of liquors, or of flowers; and by examining these substances in proper methods, as also their *Caput mortuum*, by calcination, lixiviation, and, if it will bear such a degree of fire, vitrification.

S E C T. III.

WE are next to consider the water, as drawn out of its spring, or receptacle: and to render the following heads more intelligible, instructive, and useful, I will illustrate and explain several of them; *Mineral waters consider'd out of their Spring.*

MEDICINE, them; and also deliver some practical ways of tryal, as the subjects shall require.

1. *Its actual coldness or heat.*

The heat or coldness of a mineral water, what it denotes; and how it is to be estimated.

The knowledge of the degree of coldness in the water, especially if it be extraordinary, may lead one to conjecture, whether the spring ascends from any considerable depth under ground, or whether it runs through a soil abounding with salt-petre, sal-armoniac, or some such very refrigerating substance.

The degree of the water's coldness or heat may be estimated several ways; as by its having or not having the power to coagulate essential oil of aniseed or fennel-seed; by its being, or not being able to melt bodies, of different dispositions to fusion, as butter, tallow, bees-wax, &c. to coagulate the whites of eggs, or dress them in their shells, &c. but the best method is to plunge into the water the globulous part of a good hermetically sealed thermometer, whereon the degrees of cold and heat are carefully mark'd.

2. *Its specific gravity.*

The advantages of knowing the specific gravity of a mineral water.

The knowledge of the specific gravity of a mineral water may be of great use to discover its nature; not only by enabling men to distinguish that from other waters, but by affording a considerable and double information. For by comparing the weight of the proposed liquor with that of common water, we may, in case the former proves the heavier, be assisted to estimate with what proportion of salt, ferruginous, or other mineral substance, it is impregnated; and if it be very light, or lighter than common water, it may, with probability, be concluded, that the substance that impregnated it, is either very small in quantity or proportion, but of a spirituous and volatile nature; which is a discovery of no small moment in this affair. And tho' it may seem a paradox, that the water impregnated with a metalline or mineral substance should be lighter than common water; yet upon tryal, carefully made, I have found some mineral waters, as particularly that of *Tunbridge*, that of the *German-Spaw*, and of some of the *Islington* springs, to be manifestly lighter than common water: and some taken up at *Tunbridge*, has prov'd lighter than common water, purified by distillation.

Yet I would not in all cases refer this surprizing levity to the admixture of lighter corpuscles; because some tryals have convinc'd me, that much of the comparative lightness proceeds from the mineral waters possessing a smaller quantity of common salt than ordinary water contains. My experiments, however, did not satisfy me, that this want of salt was the sole or adequate cause of the lightness of the waters I examined.

The method of determining it, shew'd by examples.

But to discover such minute differences, requires exact instruments; and, indeed, to speak freely, there are few upon whose reports I durst confidently rely for the specific gravity of mineral waters. To weigh liquors with accuracy, more care and skill must contribute with nicer

in-

instruments than often fall to one man's share. And yet when physicians, or others, weigh mineral waters, they usually do it in an apothecary's shop. The most accurate method, that I am acquainted with, to compare the different weights the same sinking body has in common water, and in the liquor propos'd, requires skill in hydrostatics, as well as good instruments, and is practicable by few. The way of comparing waters by the greater or lesser degree of submersion of the same cylinder, or other floating body, is scarce accurate enough; wherefore, I chose to make use of a very thin round vial, with a flattish bottom, that it might stand upright, and be very light, which was furnished with a neck as long as a goose's quill, drawn very even into a hollow cylinder of above three inches long, and fitted at the top with a little gap, to hinder the water from ascending above the due height.

This glass contain'd three ounces, a half, and forty-three grains of common water, yet, when empty, weigh'd but six drams, and forty-two grains; whence I cou'd use it, in such a balance, that the addition or detraction of half a grain, or less, would make either scale preponderate; so that, tho' capable of holding water enough for accurate tryals, yet when filled, 'twas not too heavy for a tender balance. In this vessel, therefore, we carefully weigh'd several liquors; and among others, different mineral waters; some of which we found as follows; the glass being always fill'd to the same height, and weigh'd in the same balance. *

| | oz. | dr. | gr. |
|--|-----|-----|------------------|
| Common water | 3 | 4 | 43 |
| Common water distill'd | 3 | 4 | 41 |
| Atton water | 3 | 4 | 48 $\frac{1}{2}$ |
| Epsom water | 3 | 4 | 51 |
| Dulwich water | 3 | 4 | 54 |
| Stretham water | 3 | 4 | 55 |
| Barnet water | 3 | 4 | 52 |
| North-hall water | 3 | 4 | 50 |
| German-Spaw water | 3 | 4 | 40 |
| Tunbridge water | 3 | 4 | 38 |
| Islington water, from the music-house | 3 | 4 | 36 |
| Islington water, from the vault with steps | 3 | 4 | 39 |
| Islington water, from the cellar | 3 | 4 | 39 |

Weighed

From hence it may appear, that as several mineral waters, which contain salts, are considerably heavier than common water; so some,

* Water will have different densities, according as the warm or cold air affects it; whereby a mineral water may be considerably influenced, if carried far from the spring, before 'tis examined. See *Philos. Trans.* N^o. 315. p. 269.

MEDICINE: especially ferruginous waters, are impregnated with such a fine substance, as to be lighter than common water.

3. *Its transparency, muddiness, or opacity.*

4. *Whether the mineral water will, by standing, let fall, of it self, any oker, or other earthy substance, especially if the liquor be kept from the air.*

The natural precipitate of a mineral water, to what discoveries it may lead.

This article may frequently help to discover what kind of soil the water has passed through, and is also useful to distinguish the spontaneous residence that the liquor lets fall by mere standing, from that they call the *Caput mortuum*, which remains after the total evaporation of the water; by which means, also, the weight of the latter may be more truly known. Not to mention other mineral waters, I found some from the *German-Spaw*, brought very well stopp'd, to London, afforded, by long standing, a pretty quantity of terrestrial substance, that look'd almost like yellow oker, and perhaps was greatly allied to it in nature. The article mentions if the liquor be kept from the air, because I have found that some liquors, by being exposed to the free air, wou'd have copious and surprizing substances separated from them, as if the air contain'd some precipitating salts fit to work on the fluids.

Microscopical observations to be made upon mineral waters.

5. *Whether any thing can be discovered in the mineral water, by means of the best microscopes, well adapted to view it.*

Having caused a young person, who was used to microscopical observations, to look upon some mineral waters through the best glasses; he could discern no difference between them and common water. But notwithstanding this, the tryal ought to be repeated by various persons, on several waters, with different microscopes, in differing lights.

'Tis thought by several ingenious persons, that the little bodies discovered by Mr. *Leeuwenhoek*, and since by others observed in pepper-water, are not living creatures, but little inanimate concretions casually form'd and carried up and down in the liquor. But the following experiment shews the contrary. Having laid upon the microscope part of a drop of water, wherein I saw numberless particles in brisk motion, we then put to that liquor with a bristle, part of a drop of spirit of salt, which, as we expected, presently deprived them of their motion, and left them to be carried slowly to and fro in the liquor; so as to make it visible that they were then dead, and were alive before.

6. *Its colour.*

7. *Its odour, whether acetous, vinous, sulphureous, bituminous, &c.*

Various odours observable in different mineral waters.

The odours of several mineral waters are best judged of at the spring-head, or other receptacle, whence some of them being remov'd, scarce afford any odour at all, perceptible by us.

Perhaps the sulphureous scent that is sometimes perceiv'd in *Tunbridge* and other waters, in their sources, may, in part, proceed from loose exhalations that casually happen to be mixed with, but do not constantly belong to the water.

The vinous odour is mentioned among others, because I am credibly informed, that in *France* there is a mineral spring of that scent. MEDICINE.

I mention the bituminous odour, distinct from the sulphureous, because men are too apt to confound them, and take all fetid mineral waters for sulphureous; tho' several of them are manifestly bituminous, as may be gather'd not only from their proper odours, but from some drops of petroleum, that are found swimming upon the water.

It seems, also, not unlikely, that sometimes a spring may partake both of sulphur and bitumen, mix'd together by the subterranean heat; for I have found, that I could easily melt and incorporate these two substances

8. *Its taste, whether acid, ferruginous, vitriolate, lixivate, sulphureous, &c.*

9. *Whether any change will be produced in the transparency, colour, odour, or taste of the mineral water, by its being taken up at the spring-head, or other receptacle, or removed to some distance; by its being kept stop'd or unstop'd, for a greater or lesser space of time; by its being much heated, or refrigerated, and, also, by its being turned into ice by cold, naturally or artificially produced, and thawed again.*

This is a necessary article, because many persons who drink mineral waters, cannot well, either for want of strength, or conveniency, repair immediately to the spring-head, but are obliged to drink them in their beds, or lodgings, and, perhaps, to have them transported from a foreign country. Many purging waters are found to retain their laxative virtue, and that, perhaps, for a considerable time, tho' carried to places distant from those they rise in. In such ferruginous waters as are lighter than common water, I found a manifest difference with regard to their transportation; for most of them, even such as will bear removing, have something of freshness and quickness at the spring-head, that they afterwards lose. And some do not only lose their briskness by being removed, tho' in vessels close stop'd, but also the power of producing, with the powder of galls, a purple colour; as I found by trials purposely made, in more than one of these mineral waters; which, to prevent fraud, I sent for to the springs themselves, by servants of my own; who, tho' they carried glass-bottles along with them, and had no other errand but to fill and stop them carefully, yet by their bringing them less than a league, I found them so alter'd, as no longer to afford a purplish colour, with powder'd galls, but a deep reddish one; whilst the *German-Spaw* waters almost constantly, here in *London*, afforded with the same powder, a rich purple colour: and *Tunbridge* waters gave the like, but not so deep, when I received them at *London* very well stop'd; which is a circumstance of great moment. For, more than once, I have received at *London*, waters sent me by physicians from *Tunbridge*, which yet wou'd, by no means, yield with galls a purplish colour. And I found, that even the *German-Spaw* water wou'd soon lose its faculty of turning purplish by galls, if it were considerably heated. But the same *Spaw* water

The alterations caused in mineral waters by transportation, and being exposed to the air.

MEDICINE. water being, in the summer-time, kept all night in an open vessel, did, till late the next morning, retain a disposition to be made purple, by the admixture of galls; but it lost that disposition before the next day.

10. *The thinness, or viscosity of the mineral water.*
11. *Whether the water be more easily heated and cooled, dilated and condensed, than common water.*
12. *Whether the mineral water will, of it self, putrefy; and if so, whether sooner or later than common water; and with what kind, or degree, of ill scent, and other phenomena.*
13. *The change of colours producible in it by astringent drugs, pomegranate peels, balauftians, red roses, myrobalans, oak leaves, &c. as also by some juices of the body.*

Remarks upon the common methods of examining mineral waters by galls.

Since the change of colour that mineral waters produce in the infusion, or tincture of galls, is the most usual, and almost the only way whereby physicians examine them; I shall set down some remarks which I have made about this method of proof; and the rather, because it may, *mutatis mutandis*, be usefully applied, to find the qualities of mineral waters, by colourations made with other materials. First then, it may be observed, that an infusion, or tincture of galls in common water, is not necessary to try if a new colour will by them be produced. I usually keep their powder in a glass, exactly stopp'd, to have them in readiness to mix with the water, and so alter its colour immediately, if galls will do it; for to draw the tincture of galls with simple water, often takes up several hours; and the tinging parts are, also, much weakned by being diluted. But if a tincture be required, the powder of galls tied close up in a rag, and hung in the liquor, makes the infusion less muddy.

I have observed those parts of the infusion of galls, especially when made by heat, that produce the new colour with ferruginous waters, are very apt to fly away; the infusion often becoming unfit to alter the colour of the waters, whilst it self appears high-coloured. Upon which account, I choose to make the tincture of galls a little before I use it; or if I employ dry galls, to take powder that is not stale.

'Tis no safe way, and may prove very erroneous, to mix galls, or their infusion, carelessly, with the water to be examined; for those who are curious to make good ink, will be easily persuaded, that the deepness of the colour, greatly depends upon the proportion of galls to the other ingredient; and, accordingly, that by putting a much greater, or a much less quantity of galls, into a certain quantity of a mineral water, the colour resulting may be more or less intense. To obviate this inconvenience, I make my infusion with a certain weight of the powder, in a determinate weight of water; for instance, I put about five grains of powder'd galls, to steep for five hours, in an ounce of water; but if I use the dry powder, I put three or four grains into an ounce of the liquor to be examined; which is a way far more cer-

certain than the common, where the ingredients are estimated by guess. Different proportions of powder'd galls are applicable to the same quantity of liquor; for I have observed, that there is a great inequality among the mineral waters, in which it may be employed. I have found by trial, that in an ounce of the *German Spaw* water, a single grain of that powder wou'd immediately produce a deep purple colour.

'Tis an inconvenience, that not only galls, but other drugs, impart a high tincture of their own, to the common water wherein they are infused; and, therefore, it were to be wish'd, we had some drug, that, without communicating a colour to the common water it impregnates, wou'd afford an infusion fit to strike a blackish, or a purple colour, with ferruginous waters.

Tho' it be useful, 'tis not always necessary, to employ galls, to strike a colour in mineral waters; for the same thing may sometimes be done, tho' more faintly, with oak-leaves; and we may successfully substitute for the same purpose, some other astringent vegetables, as dry'd red-rose leaves, the peel and juice of pomegranates; and that notable styptic, the blossoms of the same plant, vulgarly called *balauftians*; to which may be added, myrobalans, log-wood, &c. the strong infusions whereof I have found to give a tincture very dark and blackish, with some ferruginous liquors.

Since the galls, &c. to be infused in common water, are not always of the same goodness or strength, 'tis adviseable, not so to trust to any determinate proportion thereof to the water, without the assistance of the eye, to judge by the colour of the tincture, whether the liquor be duly impregnated.

'Tis hinted, that animal liquors may be employed to produce new colours with mineral waters; because 'tis usually observed in the ferruginous kind, such as those of *Tunbridge*, the *Spaw*, &c. that the gross excrements of the lower belly, are blacken'd by a mixture of their metalline parts; and in *Tunbridge* waters, particularly, I have observed, that after the drinking of large doses of them, the root of the tongue, and, perhaps, some neighbouring parts, wou'd also acquire a dark colour.

Tho' the way of trying mineral waters, by the change of colours produced in them by galls, be useful, and recommended by being easy, cheap, and expeditious; yet I do not take it to be either of that extent or certainty as is vulgarly presumed. For, perhaps, its only considerable use is, to discover by striking or not striking a blackish or purplish colour with a mineral water, to manifest it to be, or not to be, either of a vitriolic, or a ferruginous nature. But there are many metalline ores, and other mineral bodies, which, not participating of iron, will remain undiscoverable by this means, and yet strongly impregnate the water. Thus, for example, to try, whether, if arsenic were mingled with water, galls would discover it, by producing a dark colour therewith; I put some of the powder of them into a decoction

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I might add, 'tis a mistake that the infusion of galls will certainly discover a mineral water to be vitriolic, by becoming black or purple therewith. This holds true, indeed, if in the vitriolated water, iron be the predominant mineral, or considerably participated by the liquor; but if the dissolved vitriol be altogether copperish, I have found, by several trials, purposely made with a strong solution of *Roman* vitriol, that it wou'd not, with the infusion, or tincture of galls, afford either a black, or a blackish, but only a thick and muddy colour.

I remember, that from the northern part of *England*, where there are several mineral waters, a virtuoso sent me a large quantity of very whitish earth, which he suspected to be of a peculiar nature. Upon examination, it appeared to contain a considerable proportion of lead-ore, corroded by some mineral salts, and incorporated with the soil; so that if search had been made for mineral waters, in the place from whence this earth came, 'tis probable, that some peculiarity being found in the taste of the water which pass'd thro' the same, it wou'd have been taken for a mineral water, tho' it wou'd have been hard to determine what mineral it partook of; and, perhaps, by endeavouring to solve the doubt, by drinking it, very bad effects might have thence ensued. But, probably, the sulphureous spirit we shall presently describe, wou'd have shewn that water to be impregnated with a body of the nature of vitriol, but not the common sort. For tho' galls give no very blackish colour to a solution of *Saccharum Saturni*, that is, the vitriol of lead, in distill'd or rain-water; yet I found this volatile sulphur wou'd soon manifestly do it: which expedient I made use of, because I had not then at hand the ores of lead, copper, &c. For the same reason I contented my self with the solutions of the several metals in their proper menstrua; for 'tis probable, that the metalline parts of the ores, wou'd have afforded either the same, or similar solutions, in the same menstrua; which consisting of nitre, sea-salt, and vitriol, bodies that abound in several parts of the earth thro' which springs flow, their several impregnated waters might exhibit phenomena of the

the same kind. We made then, among others, a solution of fine gold in *Aqua regis*; another of common running mercury in *Aqua fortis*; and a clear one of tin, in a peculiar solvent that readily acts upon it, and keeps it permanently dissolv'd. To these solutions I put galls, without obtaining any blackish colour, except from that which contained gold; but with our sulphureous liquor, we obtained notable changes of colour, tho'twas dark in all of them except one, or tending to blackness. And tho' for that reason a careless eye might judge them indifferently blackish, yet, since the degrees, or some other modification of the same dark colour, seemed plainly not to be the same in them all; 'tis possible, that a very careful view may discern some little differences between those obscure colours, from whence to form a conjecture, what metalline substance is contained, or at least predominates in the respective liquors. And I particularly remember, that the colour which arose from our sulphureous liquor, and the solution of tin, was manifestly distinguishable from those produced in any of the other solutions; being not black, or blackish, nor so much as purple; but of a kind of brownish yellow.

I do not, however, slight the use of galls, &c. even as they are vulgarly employ'd; but am apt to think, that the way of examining mineral waters, by the changes of their colour, when they are mixed with proper materials, may be render'd very extensive and useful: to which purpose I wou'd recommend the following particulars. (1.) It seems necessary, that the change of colour be regarded, both while 'tis producing, and when produced, in a good light, and with a careful eye; for, by this means may be discovered several shades, or varieties, of the more principal colours, and some other circumstances, that cou'd not otherwise be taken notice of; which yet may afford good hints to a sagacious observer. (2.) The circumspection here recommended, may, perhaps, be more instructive, by a way I have sometimes practised, to vary the shades, and other phenomena of colours, produced with mineral liquors. This consists chiefly in preparing sheets of white paper, by drenching them in strong infusions of brazil, log-wood, or other convenient dying stuff, and then letting them dry leisurely in the air. Upon several parts of this paper, some drops of the mineral liquor being let fall, and then suffered to spread, and change their colour; a curious observer may, from hence, be assisted to guess, what kind of mineral impregnates the liquor, and in what quantity; especially if the liquor be of a saline nature, and on the same sheet, some other convenient mineral water, or other fluid, be likewise dropt; that the changes of colour produced by the two, may be surveyed and compared together. I, also, practised another way, somewhat different from this, by rubbing some proper powders, as that of *English vitriol*, (lightly calcined, in a gentle heat, till it becomes of a greyish colour, and friable between the fingers,) with a hair's foot upon white paper, till the finer parts thereof having lodged themselves in its pores,

The common method of examining mineral waters improved.

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without greatly discolouring it; when the superfluous dust was struck off, it became capable of affording a variety of colours, or rather shades, some deeper, and others fainter; and then I let drops of different ferruginous liquors fall thereon. Several variations of colour may, likewise, be produced by infusing, or otherwise mixing a material with the mineral water, before the tinging one be joined with it; by putting somewhat into the infusion or powder of galls, before it be added to the water; or, lastly, by dropping proper liquors, such as spirit of salt first, then spirit of urine, or oil of tartar, into the mixture of galls, and the subject to be examin'd. (3.) It is not proper to confine one's self to the use either of galls or oak-leaves; red roses, balaustians, log-wood, brazil, and other astringent vegetable pigments, may be also employ'd. For tho' some of these give a deeper tincture than galls, yet, by the diversity of colour they produce in mineral waters, an attentive spectator may discover some things that he would not be informed, or receive any hint of, by the help of galls or oak-leaves alone. Nor would I have only vegetable substances employ'd about such colourations, but sometimes animal, and often mineral ones; for by this means, experiments will be diversified, and the number of phenomena encreased; some of which may, probably, prove instructive. I know several other substances that will, as well as galls, turn black in vitriolic waters, whether of the iron or copper kind. And for a liquor that will presently turn black with either: take equal parts of pure salt of tartar, flowers of sulphur, and good sal-armoniac, reduce the first and the last to powder separately, melt the sulphur, over a gentle fire, and, by degrees, put to it the salt of tartar; stirring them well, that they may incorporate and grow reddish; then put the mixture, pulverized, into a glass-retort, pour on it the sal-armoniac dissolv'd in fair water; and closing well the junctures, distil all in sand, by degrees of a moderate fire; shifting the receiver once or twice, because the liquors will be differently ting'd and strong, and that which ascends last, may bring over but very little of the sulphur, whose volatile tincture is yet the chief thing we aim at in this operation. (4.) I question not, that he who makes a skilful use of the several drugs, and other bodies, vegetable, animal, and mineral, which may produce new colours with mineral waters, or the substances that impregnate them, will thereby discover the presence or absence of many other minerals therein, some of them salubrious or safe, and others hurtful or dangerous, that remain unobserv'd by those who content themselves to employ only galls and oak-leaves in the examination of them. For some of these liquors contain salts that, having corroded either iron or copper ores, or marcasites, do not betray themselves, by producing either an inky, a fainter degree of blackness, or a purple, with the drugs commonly made use of to change their colours. And of these salts I have met with more than one sort. (5.) I think it, likewise, very possible, that industrious men may find means to dis-

discover, by the help of this change of colours, whether orpiment, native arsenic, or the like poisonous minerals, impregnate a water, so as to make it very hurtful or dangerous. But as for sulphur, several waters may partake thereof without being perceived to do so. I have, sometimes, purposely made a liquor, limpid like spring-water, that would totally evaporate by a gentle heat; and yet this liquor was highly impregnated with a mineral sulphur, as I convinc'd several virtuosi by manifest and ocular proofs. So that if sulphur chance to be combined with any of those many hidden subterranean salts and minerals, that can suppress or disguise its peculiar odour, a water may be considerably, tho' unobservedly impregnated with it: yet this is, probably, discoverable by the change of colour, producible in such a sulphureous liquor by vitriolic bodies, and other proper materials; for tho' the spirit lately describ'd be very transparent, and totally volatile in the form of a liquor, sometimes pale; yet common *English* vitriol, as also that of *Dantzick*, which is of the copper kind, will presently turn it of a black or very dark colour. And, what seems more difficult, I have devised a method whereby it appears, that even solid copper may be so subtiliz'd and disguiz'd, as to send out a multitude of its metalline parts, with others, in the form of a transparent liquor, like common water; when by putting to it a little of another substance, as volatile and colourless as it self, it would presently disclose the metal it contained, by turning blue as a sapphire. (6.) Because arsenic is a pernicious drug, and yet has been suspected to be clandestinely mixed with mineral waters; which seems the less improbable, because some of the marcasitical bodies, wash'd by particular mineral waters, are thought to contain it; and because galls fail'd to discover this poisonous drug in water, that was copiously impregnated with it, I made some trials, to discover, at once, its existence in water, and the nature of so dangerous a mineral.

Happening, some years ago, to tast arsenic, not without a little danger and inconvenience, its poisonous nature did not from thence seem to me to consist in a highly acid salt, but to be of an exceeding corrosive or fretting nature, peculiar to it self. Of this mineral I made a strong solution in common water, wherein some skill is required to dissolve it, and mix'd a small proportion thereof with some *German-Spaw* water; then dropping into this mixture a little highly dephlegmed spirit of urine, we perceiv'd a light lactescence to be produced, and a whitish precipitate very slowly to subside therein.

We found, also, that a little oil of tartar *per deliquium*, being drop'd into some of the solution of arsenic, produced a heavy, whitish cloud, which presently settled on the lower part of the glass: we, likewise, put oil of vitriol into the said solution, but did not perceive that the oil caused a precipitation, or wrought much otherwise on it than it would have done upon common water.

To discover whether a mineral water be arsenical.

From

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From which experiments it may be suspected, that arsenic is chiefly an acid body.

But by mixing some of this arsenical liquor with syrup of violets, we found it slowly change the syrup, rather to a green, than a red or purple colour: and to another portion of the same liquor we put some of our volatile sulphureous spirit, but no precipitation ensued.

For a severer scrutiny, we used a method, that is very successful in discovering such slight degrees of acidity as are not discoverable by ordinary tryals; but we cou'd not, by this way, discern the least acidity in our arsenical solution, but rather a manifest sign of an urinous or lixivate quality. And by putting some of the arsenical liquor into a strong solution of common sublimate, made in fair water, we had a copious precipitate, such as might have been expected from an alkaline precipitant. And this was not brick-coloured, like what fix'd alkalies produce with dissolv'd sublimate, but white; such as urinous or volatile alkalies, as they call them, make with the same liquor.

Upon the whole, tho' arsenic be a very corrosive body, and, perhaps, upon that score poisonous; yet its deleterious nature seems not to consist in a transcendently acid, lixivate, caustic quality; but, as we before conjectured, in a peculiar kind of corrosiveness.

I shall add, that upon casting about in my thoughts for an useful method to examine mineral waters, suspected to contain arsenic; I, at length, made choice of vitriolate bodies for that purpose; and found, that if a solution of *Dantzick* vitriol were put to a convenient quantity of arsenical liquor, there would presently ensue a great change of colour; and a dark substance, by degrees, precipitate it self, and settle in the lower part of the glass. The like effect we found when we put *English* vitriol, (which having no copper added in its preparation, as that of *Dantzick* has, is either wholly, or almost ferruginous,) into a considerable proportion of the arsenical solution.

14. If any thing will be precipitated out of the mineral waters by salts or saline liquor; whether they be acid, as spirit of salt, or of nitre, Aqua fortis, &c. volatile alkalies, as strong spirit of urine, sal-armoniac, &c. or lixivate salts, as oil of tartar per deliquium, fixed nitre, &c.

15. To examine, by evaporation, whether the mineral water contains common salt, and if so, whether in a great or small quantity.

Common salt
contained in
mineral wa-
ters.

Because it often happens, that men have not the leisure and convenience totally to evaporate a mineral water, it may be useful, without evaporation, to discover, whether it contains any common salt; and if so, to make some estimate how copiously or sparingly the liquor is impregnated therewith. This I might easily shew how to perform exactly, if I were not justly restrained, for a while, from communicating that way of examining the saltiness and freshness of waters, whereof, by the king's command, I exhibited to his majesty some proofs, soon after mentioned in the *Gazette*; however, some guess may be made at the saltiness of waters by observing whether they will lather with wash-

wash-balls, or soap; and if they will not, what quantity of curdled matter they produce; as, also, whether they will serve for the washing of linen, and the boiling of peas tender; which two are the most usual ways that seamen take, to examine the goodness of unknown water. In several purging waters, it may be difficult to practise this method with certainty, because other salts may happen to predominate in them; but in the examination of lightly ferruginous springs, it is more to be relied upon. 'Tis remarkable, that when I used my own way of examining the saltiness of mineral waters, I found even the lightest sort of them contained common salt, but in different proportions; thus not only in the several waters of *Islington*, *Hampstead*, and some others, afforded it, but particularly those of the *German-Spaw*, and *Tunbridge*, did the same. And, indeed, I have long known, that more or less common salt is very usually harboured, unobserved, in many soils, thro' which all sorts of springs have their course.

16. To examine, without evaporation, whether the mineral water have any acidity, tho' ever so little.

Tho' acidity be so frequently a manifest quality of mineral waters, as to cause them to be divided into *Acidula* and *Therma*, yet I have found, by several trials, that 'tis not near so easy as men presume, to discover a manifest acidity in all those that are not sulphureous or hot. For, several ferruginous waters having, probably, spent what acidity they had, upon the iron-ore which they dissolved in their passage, retain but little of that property, which they manifest so faintly, by working upon coral, by any conflict with spirit of urine, &c. or by changing the colour of syrup of violets, that I shou'd sometimes have concluded, they had no acidity at all, were I not provided of a way to discover a far less degree of it, than the vulgar trials take notice of; which is by their operation upon the colours of an infusion of *Lignum-nephriticum*, made in limpid water. By this means, I found the *German-Spaw* water to retain a little acidity, even here at *London*; but several of our own ferruginous springs did not, even upon this trial, appear to have any. Nor did I find even some of the purging springs, particularly that of *Alton*, to have any discernable acidity.

17. The liquor, or liquors, it affords by distillation in balneo, and other treatment.

18. The sediment, or Caput mortuum, of the mineral water, when the liquor is totally evaporated, or distilled off; and whether the remainder be the same in quantity and quality, when severally produced by those two ways.

19. Whether the water, being slowly and warily abstracted to a thickish substance, in glass vessels exactly luted, and again mixed with the distilled fluid, wou'd re-compose a mineral water, of the same texture and qualities it had at first.

20. Whether a glass full of it, being hermetically sealed up, and boiled in common water, deep enough to keep it always covered, will have its texture so altered,

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Acidity no common quality in them.

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There is a double design in this enquiry. First, to discover whether a change of texture wou'd remarkably alter the qualities of the liquor, when the hermetical seal hinder'd the avolation of any saline, ferruginous, or spirituous parts: and, secondly, to see whether such an agitation by heat, as in the open air prevents the *Spaw* water from making a purple colour with galls, wou'd cause any manifest separation of parts in the liquor, and cause any grosser substance to precipitate, or subside. We twice attempted the experiment with *Spaw* water, but without success; for the first time, the glass broke at the bottom, before the water, wherein we immers'd it, was near boiling hot; and tho' the other glass resisted longer, and endured a greater heat, yet in a few minutes that also broke at the bottom: which disappointments a faithful historian ought not to conceal.

21. What proportion the dry *Caput mortuum* bears to the mineral water that affords it.

22. The division of the *Caput mortuum* into saline, terrestrial, and other parts not dissoluble in water, in case it contain both, or more sorts.

23. The proportion of the saline part of the *Caput mortuum*, to the terrestrial.

24. The fixity, or volatility, of the saline part in strong fires.

25. Whether the saline part will shoot into crystals or no; and if it will, what figure the grains are of; but if it will not, whether, being combined with a salt of that property, as purified sea-salt, for instance, it will then crystallize; and if it do, into what figures it shoots, and, particularly, if they are reducible to those of any species of known salts.

26. To examine whether the saline part be predominantly acid, alkaline, or adiaphorous.

To find what Salts predominate in particular mineral waters. Various ways may be proposed, to discover which of the qualities mentioned in this article, is predominant in the salt to be examined; but, I confess, I doubt whether any of them be certain.

If acidity be the predominant, it will, probably, appear by the taste, odour, or both; by working upon powder'd coral, or crabs eyes, curdling milk, turning syrup of violets reddish, destroying the blue colour of the infusion of *Lignum nephriticum*, by not precipitating with strong acid liquors, as oil of vitriol, spirit of salt, &c. and, lastly, by precipitating with oil of tartar *per deliquium*, strong spirit of urine, &c. But I still doubt, whether these proofs be absolutely certain; for, if I mistake not, I found some purging mineral waters, that wou'd not give even so slight a proof of acidity, as to destroy the blueness of the nephritic tincture, tho' they wou'd curdle milk; and, on the contrary, I found, that some *Spaw* water wou'd not curdle milk, and yet readily deprive the said tincture of its colour: which some of our *English* ferruginous waters were, at least when brought to *London*, unable to do.

The predominancy of an alkali in the salt of a mineral water, may be, probably, discovered by the lixivate taste and smell; the former of

of which may be observed in the true nitre of the ancients; by turning the syrup of violets green; by precipitating a solution of sublimate, made with spring-water; by an effervescence, or conflict with some potent acid, as *Aqua fortis*, or well dephlegmed spirit of salt; by heightning the red tincture of log-wood, or brazil, drawn with common water; to which may be added, a nicer way or two, that I have elsewhere mentioned. But I propole these methods of examination, only as they appear rational; because I have successfully tried them with other saline bodies, that were alkalizate: for, as to those mineral waters I have examined, an alkali appeared to be predominant in none of them.

But further enquiry may discover to others here in *England*, what I have not yet met with: doubtless there are in many parts of the earth, salts of an alkaline nature. And, I presume, the *Egyptians* might find, among their springs or wells, several waters impregnated with them; for I found by trials, purposely made, upon the true *Egyptian* nitre, that the native salt exhibited several of the same phenomena, with other factitious alkalies: and some salt afforded by the famous waters of *Bourbon* in *France*, being brought me to examine, I found it to be evidently alkaline; for it wou'd make a conflict with acids, and presently turn syrup of violets green.

If we suspect vitriol to predominate in the saline part of a mineral water, we may endeavour to discover it, by its blackning a solution of galls; by its vomitive operation upon the drinkers; (tho' this may sometimes prove uncertain; especially because an invisible mixture of arsenic, or, perhaps, arsenical fumes, may give the water an emetic quality;) by putting alkalies to a strong solution of the supposed vitriol, and observing whether it will afford a yellow, or yellowish precipitate, if salt of tartar, or spirit of urine, be dropt into it; and, lastly, by taking notice, whether a sulphureous spirit will make a blackish, or a very dark colour with it; as I found it would do with several vitriolic liquors; and even in one, wherein we had dissolved but a grain of a natural vitriolic substance, in above four or five thousand times its weight of syrup or water. But I do not remember to have found vitriol a manifest ingredient in any of the waters about *London*: which seems the more remarkable, because several places about that city abound with marcasites, the parents of vitriol. And a curious *French* gentleman, who had a particular occasion to take notice of the sediments of many mineral waters in his own country, told me, he never met with any that was manifestly vitriolic: and he seem'd to be of opinion, that no vitriolic spring had yet been discover'd, among the many mineral ones of *France*.

Since we so rarely meet with either manifestly acid, or evidently alkaline salts, in our *English* mineral waters; it may deserve a serious enquiry, what other salts they may be impregnated with; and especially from what salts, the purgative virtue that is found in many of

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27. The observables in the terrestrial portion of the *Caput mortuum*, in reference to the saline; its colour, odour, volatility, or fixity in a strong fire; its solubility or insolubility in several menstrua, as spirit of vinegar, spirit of wine, oil of tartar, &c.

Different quantities of *Caput mortuum* afforded by different mineral waters.

'Tis surprizing to observe, how great an inequality there sometimes is, in the proportion that the same quantity of two different mineral waters bears, to the *Caput mortuum* they respectively afford: since a pound, for instance, of one, may, after evaporation, leave behind it, perhaps, more drams of a dry substance, than a pound of the other leaves grains.

As far as I have hitherto observed, those ferruginous waters that are MEDICINE.
not heavier than common water, and usually prove diuretic, afford but little *Caput mortuum*, or dry substance, upon the total evaporation of the liquor; whilst mineral waters that are purging, and manifestly more ponderous, *in specie*, than common water, leave, after exhalation, a considerable quantity of residue, tho' some far less than others.

From a pound of *Barnet* water, which is purgative, slowly evaporated, we obtained a dram of white powder; but from the like quantity of *Tunbridge* water, only about one grain of *Caput mortuum*: and, if I misremember not, we had but about a grain and a half, from twenty-five ounces of *German-Spaw* water.

It may seem scarce credible to many, that so small a quantity of matter, of which, perhaps, not one half is saline, or metalline, should impart a manifest virtue to so great a proportion of water: but this difficulty did not much trouble me, having purposely made several experiments, to discover how small a proportion of mineral matter may suffice, when dissolved, to impregnate common water. One grain of iron-stone, casually found near the springs at *Islington*, (from which mineral, those waters probably derive their virtue,) being opened by fire, and dissolved, as far as it wou'd, in a little spirit of salt, we let fall a drop or two of the yellowish solution into a great proportion of the infusion of galls, to which it presently gave a deeper colour than *Tunbridge* water, or even that of the *German-Spaw*, usually affords, here at *London*, with the powder of galls: so that we imagined, if we had then at hand a competent quantity of the infusion, the remaining part of the ferruginous solution wou'd have colour'd a ten times larger quantity of the infusion, than our trial was made upon. This will be easily credited by him, who considers an experiment we, afterwards, made to the same purpose, by dissolving half a grain of a good marcasite, taken up not far from *London*, in a small quantity of spirit of nitre. This solution we put into a pound of a pretty high tincture of galls, made by infusing them in common water; and finding, as we expected, that the mixture grew very dark, we filled a vial with it, and emptying that vial into a larger glass, we filled the same vial three times with common water to dilute it; notwithstanding which, this new mixture, being put into one of our usual glasses, appeared of a colour much deeper than that which the water of *Tunbridge*, or the *Spaw*, had formerly given with the powder of galls: so that, probably, if another vial of common water had been added, it wou'd yet have afforded a purple colour, if not a deeper: so that one part of a dissolved marcasite communicated a tincture to 61440 parts of the infusion of galls. And what makes the experiment more considerable, is, that this small quantity of marcasite, was not it self wholly ferruginous, or metalline: for, from our *English* marcasites, as well as others, I have obtained a considerable quantity of sulphur like the common sort; besides which, they afford a considerable one of a terrestrial substance.

MEDICINE. Since, then, the marcasite impregnated so much water with its gross parts, obtain'd by a bare solution, it seems highly probable, that the same quantity of liquor may be impregnated by a far less quantity of mineral matter, attenuated by being rais'd in the form of fumes or exhalations: and, that imperfect or embryonated iron may be thus rais'd, appears from hence, that iron will manifestly emit copious fumes, without the help of external fire. And if it be with some such spirituous and volatile exhalations, that a mineral water, as those of *Tunbridge* and *Islington* is impregnated, 'tis easie to conceive how they may soon lose their chief virtues by the avolation of their fine parts, upon their being removed to a distance from the spring-head. And to make it probable, that vitriolate corpuscles may be made to ascend without losing their nature, I shall here mention an experiment that I devised, to give some light into this matter. I had often found, by tryal, that a spirit, richly impregnated with volatiliz'd sulphur, wou'd, with vitriol, whether in the form of a powder, or a solution, produce, in a trice, a very dark or blackish colour: and guessing, that in mercury, turn'd, by the addition of salt and vitriol, into corrosive sublimate, many of the vitriolate corpuscles might ascend with the mercurial ones, I drop'd a volatile sulphureous tincture upon good sublimate, and found it presently turn to a very opake colour. To shew, also, that to make a great dilatation or dispersion of the ferruginous corpuscles of an ore or mineral, there needs no spirit of salt, or the like distill'd menstruum; I procured, from a place where artificial vitriol is made, some of the liquor they employ before they cast in iron, that being corroded thereby, it may increase the weight, and give solidity and some other qualities to the design'd vitriol. For tho' this liquor be made without any chymical menstruum, barely by rain or snow-water, that impregnates it self with saline or metalline particles, in its passage thro' beds of marcasites, that lie exposed to the sun and air; yet in this water such numbers of ferruginous corpuscles are dispers'd, that having let fall four drops of it into twelve ounces and a half of common water, this liquor, as I expected, was thereby so much impregnated, that, with powder of galls, it presently produc'd as deep a colour as good *Tunbridge* water would have done. So that supposing a drop of this liquor to weigh about a grain, as by some tryals purposely made we found it did, we see that one part of the vitriolate water was able, manifestly, to impregnate fifteen hundred parts of common water. And yet, of these four drops or grains of the vitriolate liquor, a considerable part may very probably be concluded, from the way of its production, to have been rain-water; since, to examine this supposition, we slowly evaporated some ounces of that liquor, and found the remaining dry substance amounted not to the fourth part of the weight of the whole; whence 'twas easie to conclude, that one grain of vitriolate substance wou'd have impregnated six thousand times its weight of common water, so as to make it fit

to

to produce, with galls, a purple tincture. We afterwards found, upon a careful tryal, that the experiment will hold, tho' the proportion of the water, to the grain of tinging substance, shou'd exceed that above-mentioned by the weight of some hundreds of grains.

28. *Whether, and how much, the earth of the mineral water loses by a strong and lasting ignition; what changes of colour, &c. it thence receives; whether it be, of it self, capable of vitrification; and what colour it will impart to fine pulveriz'd Venice glass, when exactly mix'd therewith, and flux'd into a transparent glass.*

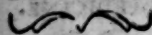
29. *The œconomical and mechanical uses of the mineral water in brewing, baking, washing of linen, tanning, dying, &c. as these may, severally, assist in discovering the ingredients and qualities of the liquor.*

30. *How to imitate the natural medicinal waters, by chymical and other artificial means, in order to discover the quality and quantity of the ingredients that impregnate the same.*

To make a succedaneum for mineral waters, such as those of the *Spaw* or *Tunbridge*, we took one part of very good filings of iron, and ten parts of good distill'd vinegar. These were put into a bolt-head well stop't; and then, in a mild heat of sand, we digested them for about two days, and afterwards augmented the heat till the liquor appear'd of a deep orange colour, yet transparent. Part of this tincture we poured off, and kept well stop'd by it self; because, tho' by a longer digestion and a greater heat, we obtain'd a very red tincture, yet we did not so much value it, because, when the menstruum is too much impregnated, the metal usually precipitates, and the fine colour is destroyed. Of the first tincture we let fall four drops into eight ounces and an half of clear common water, whose colour was not thereby sensibly alter'd; and the vial, containing this mixture, being well shaken, that the tincture might diffuse it self the more thorowly, we kept it carefully stop'd for use, as being our factitious *Spaw* water. A spoonful or somewhat more of this, with about a quarter of a grain, or less, of good fresh powder of galls, would presently afford a purplish tincture, like that of natural springs impregnated with iron; and if the mouth were wash'd therewith, it appear'd to have, like those natural waters, a manifest ferruginous tast. But these artificial *Acidula* ought to be administer'd soon after they are made; for experience has inform'd me, that when kept too long, they lose much of their briskness and force. I sometimes here perceived, there would subside to the bottom, a certain reddish substance, as it were oker, which shew'd the degeneracy of the liquor: and some such thing I have observ'd in natural chalybeate waters, too long or negligently kept.

31. *Particulars omitted, but directly belonging to the history of mineral waters.*

32. *Miscellaneous observations and experiments, indirectly referable either to one or more of the specified heads, or to the common subject of them all.*



S E C T. IV.

Heads for the natural history of a mineral water considered as a medicine.

WE come, in the last place, to give a set of heads for the history of a mineral water, consider'd as a medicine.

1. To what tempers and constitutions the propos'd mineral water is the most proper, to what less proper, and to what noxious or inconvenient.
2. In what stated diseases and particular cases it is proper, or suspected to be dangerous, if not certainly hurtful.
3. What difference there is between the water taken up, and presently drunk at the spring it self, or other receptacle, and when carried to some distance from thence, whether in open or well clos'd vessels.
4. The manifest operations of the water in those who take it, whether by vomit, stool, urine, or by any two, or all of these ways together.
5. Whether any occult virtues are discoverable in the mineral water, and if any, what they are.
6. What difference in the effects of the mineral water proceeds from its being drunk, all of it, quite cold, or hot, or luke-warm, or one part when 'tis in one of these tempers, the rest when in another.
7. How to promote or facilitate the operation of the water in some, by taking it in bed, and in others, by moderate exercise.
8. What assistance may be afforded to the operation of the water, by giving with it, especially in the first draught, something to make it pass the better, to correct its crudity, or strengthen the stomach and viscera.
9. What advantages may accrue from preparing the patient's body before he enters upon his course of the waters; and what inconveniencies may attend the neglect of such preparation, especially in gross, foul, or much obstructed bodies.
10. The assistance the water may receive by gentle purging medicines, discreetly given at proper intervals.
11. The most proper dose or quantity of the water to be taken at once; the compass of time wherein it shou'd be all drunk; and the gradual encreasing and lessening the dose required at the beginning, and sometimes before the end of the whole time appointed for taking it.
12. How much the greater or lesser space of time, spent in taking the water, conduces to its good effects; and what is the fittest measure of time to continue the drinking of it; respect being had to the patient's strength, disease, the time of the year, the accidental temperature of the air, and other considerable circumstances.
13. Whether the drinking of the mineral water, for several years together, be found necessary, or more beneficial, than to intermit it sometimes, for a year or two, or perhaps longer, and then to repeat the use of it.

14. The

14. The regimen, as to meat, drink, exercise, sleep, &c. that ought to be observed by those who take the water; and of the inconveniencies that are apt to follow a neglect herein.

15. The signs that shew the water to work kindly and effectually; and the signs of its doing the contrary; with those of its having proved already hurtful; or of its being likely to prove so.

16. The inconveniencies, or ill accidents, observed to happen, either during the course, or some time after 'tis over; especially to persons of particular constitutions, or in particular circumstances; and the means to prevent or remedy such inconveniencies.

17. Whether it is necessary, or useful, to take physic, after the course is finished; and, if it be, what are the fittest times and medicines to be employed, to prevent any bad effects; and what is the danger of neglecting to make use of them.

18. Whether, and how the mineral water may be usefully given, by being added to other liquors, or things; as by boiling meat in it, or by receiving, together with the addition, a farther preparation, as when wine, &c. is mixed with it; or when with milk 'tis made into posset-drink; or, lastly, when brew'd with malt alone, or with that and hops, and so turned into ale or beer.

19. Whether any such saline, or other substance, may, by evaporation, inspissation, calcination, &c. be extracted from the mineral water, as, being given in a small dose, may be substituted as a succedaneum to large quantities of the natural water.

20. Of what use the mineral water may prove, when outwardly applied, as by washing sore eyes, or ulcers bathing in it, &c. and whether the mud, or sediment, it leaves where it passes, or stagnates, being externally applied, may have the same, or other medicinal virtues; and if so, how that is to be administered to make it exert them.

21. Some mechanico-medical trials to be made upon animals, which may help us to conjecture at the qualities of the mineral waters; as by injecting it into the veins of a dog, to try, whether it will coagulate his blood, make it more fluid, or powerfully operate by vomit, stool, or urine; as also by keeping a dog very long, without allowing him any other liquor than the mineral water.

But I propose such particulars as these, only as analogous experiments, or succedanea to trials, that cannot well be made in the human body. And, indeed, all the heads of this third part of our designed history, belong properly to physicians; many of whom are far better qualified to cultivate this subject, than I: for which reason I willingly resign it into their hands.

Thus much, however, I must be allowed to say, that to compile an accurate history of mineral waters, is a task of exceeding great difficulty. There are so many circumstances of seasons, weather, place, with a multitude of other contingencies, which may vary the phenomena and effects of these waters, that to comprize so many different things at once, and survey them at one view, so as to be able to pronounce with

MEDICINE. with certainty, upon the nature, the medicinal operations, and other effects thereof, seems, till farther trials and enquiries have been made about them, a thing impossible.*

* That the nature and properties of mineral waters may change in time, or by accident, we have a remarkable instance in those of *Passy* in *France*, which *M. du Clos* first examined, with great care; and, in a few years after, *M. Lemery* coming to examine them again, found them quite different. See *Hist. de l'Acad. A.* 1701. p. 78.



CAUSES

CAUSES

OF THE

Wholesomness and Unwholesomness

OF THE

AIR.

THE principal thing upon which the wholesomness and unwholesomness of the air depends, is the impregnation it receives from subterranean effluvia. And, tho' this be a cause generally overlooked by physicians, yet 'tis often very considerable in its effects.

The healthy or unhealthy state of the air, greatly depends upon subterranean effluvia.

The effluvia that affect the air, may be distinguished into several sorts, according to their respective natures: but I shall now only take notice of the differences which may proceed from place and time. With regard to the former, some of them arise from the crust, or more superficial parts of the earth; and others have a deeper origin, ascending out of the lower parts, and bowels, of the terraqueous globe. And in respect of the latter, some subterranean effluvia are almost constantly sent up into the air, which I therefore call ordinary emissions; and others ascend but at certain times, distant from one another; and these I call extraordinary emissions; whether they come at stated seasons, and so deserve the title of periodical; or uncertainly, sometimes with far greater, sometimes with much smaller intervals; and so may be called fortuitous or irregular.

'Tis frequently observed, that marshy grounds, and wet soils, are unhealthful, because of the moist and crude vapours, that the stagnating waters send up too plentifully into the air. On the other hand, dry soils are generally look'd upon as healthy. And, indeed, these observations seem most commonly to hold true: but, besides what can be justly ascribed to such moist vapours, or dry exhalations, in many places

MEDICINE. the wholesomeness or unwholesomeness of the air, may be ascribed to other sorts of effluvia, from the soil, than those that act merely, or, perhaps, principally, either as moist or dry.

To deliver my thoughts the more distinctly upon this subject, I shall lay them down in four observations, or propositions.

P R O P. I.

It seems probable, that in several places, the wholesomeness or unwholesomeness of the air, in the general, may be, in great measure, due to subterranean expirations, especially to those I call ordinary emissions.

For, in some places the air is observed to be much more healthy, than the manifest qualities of it would make one expect: and, in many of these cases, I see no cause, to which such a happy constitution may more probably be ascribed, than to friendly effluvia sent up from the soil into the air; which particles, either by promoting perspiration, or by hindering the production, or checking the activity of morbidic ferments; or by mortifying and disabling some noxious particles, that would otherwise infest the air, &c. may greatly contribute to keep the bodies of such as live in that air, in the regular and desirable state, we call health. I know 'tis generally thought, that mineral bodies send up exhalations, hurtful to plants and animals; but when we speak of subterranean things indefinitely, we include more particulars than most men are aware of; there being a great number and variety of bodies, that nature has lodged in her store-houses under the surface of the earth. And of these differing sorts, tho' 'tis probable the effluvia of the greatest part are unhealthful to man, yet there may be others friendly to him. It has been observed, that over some tin-mines in the western parts of *England*, not only trees, but far more tender plants, prosper and flourish; and I have seen verdent trees growing just over a vein of another sort of mineral, that lay near the surface of the earth: 'tis, likewise, observable, of such as constantly dig in those tin-mines, that they arrive at a great and vigorous age. And an ancient possessor of some of these mines assured me, that tho' most of those visible fumes had a smell that participated of sulphur, or bitumen, yet others were well scented. I remember too, that a friend of mine, and another gentleman, being partners in a chargeable attempt to discover a mine; in digging deep for it, they accidentally broke into a vast subterranean cavern; into which, because the diggers would not venture, one of these gentlemen caused himself to be let down, and there found the air very temperate and refreshing; so that he long breath'd it with delight: and on the soil he discovered many and various minerals, most of them embryonated, or imperfectly form'd; with plenty of a kind of mineral earth, whose smell was fragrant, and very pleasant, both in his judgment, and that of some ladies. And, when

when some of those minerals were brought to me, a small lump of this MEDICINE.
 earth that was among them, having now been kept so long in the air, as to spend most of its odoriferous particles, yet the smell it still retain'd, was, tho' faint, yet pleasing.

That from fossils lying hid under the surface of the earth, and having a considerable spread, there may plentifully ascend whole-som effluvia into the air, seems to me the more probable, because I observed, at a certain place in *Ireland*, a very large sheep-walk, that produced short, but excellent grafs; the spot being justly reputed very healthful: the reason whereof, from considering the circumstances, seemed owing to this, that the soil was sustained by a large tract of lime-stone, which, I suppos'd, continually emitted exhalations into the air: and it has been long and generally observed, that as far as the lime-stone extends, that tract of ground makes the snow which falls on it thaw much sooner, than on the neighbouring lands.

And a person, who had been employed in several mines, told me, that at a place in *Derbyshire*, he and others had observed, a large tract of lime-stone-land to be so warm, as to dissolve the snow that fell on it, very much sooner than another great tract bordering upon it, where the soil lay only upon free-stone.

An ingenious person, also, who had visited the *Hungarian* and *Bohemian* mines, told me, that, during his stay among the former, he often walked abroad with the overseer of them, who delighted to breathe the fresh morning air, upon some hills abounding with minerals; and that his guide made him observe, when they were over a tract of land which afforded a noble kind of ore, called *Rot-gulden-ertz*, he found the smell to be pleasing, and the air refreshing. And tho' in passing over some other mines, he found himself molested by offensive fumes, he felt no such effect, when upon that ground under which there ran veins of cinnabar, or a mine of quick-silver ore: and his guide told him, that next the *Rot-gulden-ertz*, the soil containing these cinnabarine veins, was that whose air was the most eligible for pleasure and wholesomeness. And no wonder, that in some places the subjacent fossils should impregnate the air with whole-som effluvia; for I once saw a tract of ground, famous for a good pottery, where, besides many other mineral earths which I took notice of, there was a groove, that reached fifteen or twenty feet beneath the surface of the earth; whence they dug up a kind of white clay, so richly impregnated with subtile and noble parts, that it afforded a chymist or two of my acquaintance, a large quantity of a subtile spirit, of a volatile and saline nature, which, upon trial, they highly extoll'd for its cordial, and other virtues in physic; and which, by some peculiar mechanical trials I made with it, I concluded to abound with a volatile salt, not unlike that of urine or hartshorn. Since then, some suspected fossils may be enriched with medicinal and fugitive salts and spirits; it may reasonably be suppos'd, that these ascending into the incumbent air, will
highly

MEDICINE. highly conduce to the wholesomeness of it. And the chymical examinations I have made of some boles, and other bodies, which are unregardedly comprized under the confus'd notion of earths, makes me suspect, that there may be far more species of salubrious fossils, than are yet taken notice of.

But it will appear the more probable, that subterranean tracts, of great extent, may, for a very long time, send up into the air, large expirations, not discernable by any of our senses, from considering, that the common air wherein we live and breathe, always abounds, and, for many ages, has been impregnated with the plentiful magnetic effluvia of the earth, which our *Gilbert* and others, have proved to be a great, tho' languid magnet; and whose emanations, as they constantly stream thro' the air, are capable of passing thro' the pores of glass it self, and acting almost instantaneously, yet manifestly, upon bodies hermetically sealed up in it. But, tho' it may hence probably appear, that the wholesomeness of the air in some places, is chiefly, or at least in part, due to the wholesom expirations of subterranean bodies; yet, generally speaking, the air is depraved, in far more places than it is improved, by being impregnated with mineral expirations. And, indeed, among the minerals known to us, there are many more noxious, than wholesom: and the power of the former to do mischief, is far more efficacious than of the latter to do good; as we may guess by the small benefit men receive in point of health, by the effluvia of any mineral, or other known fossil, in comparison of the great and sudden damage that is often done by the expirations of orpiment, sandarach, and white arsenic. The ingenious person, lately mentioned, told me, that when his guide and he walked over some veins of these noxious minerals, he met with several odorous steams, which, tho' differing from one another, agreed in being all offensive to him; and, particularly, some of them by their sharpness, and others by giving him a difficulty of respiration. We may here take notice of the *Averni*, said to be found, some in *Hungary*, and some in other countries; where there ascend out of the earth such noxious and plentiful exhalations, as kill the animals that draw in the air they infect; and some of them are able to suffocate even the birds that fly over them. But there are numerous places, where 'tis less manifest that hurtful exhalations ascend into the air. Whole tracts of land, near the surface of the earth, sometimes abound with marcasitical minerals, as these do with a sharp vitriolic salt; which, together with the ill-condition'd sulphur they also plentifully contain, ascend into the air, and render it corrosive. I once took some *English* shining marcasite, and caus'd a pound of it to be distill'd in an earthen vessel, with a strong fire; by which means, notwithstanding its dryness, I obtained two or three spoons-full of a limpid liquor, that smell'd very strongly, like *Gas sulphuris*; and appear'd manifestly to be of an acid nature, both by the tast, and by readily corroding, and dissolving unbeaten coral, even in the cold. And the mine-

mineral afforded me, together with this liquor, about an ounce and three quarters of inflammable ſulphur; part whereof, aſcending in the form of very agile corpuscles, faſten'd themſelves all about the inſide of the receiver, and there compos'd ſeveral thin coats, or films, as 'twere, of ſulphureous matter ſticking to one another; which, at their being firſt taken off, and for ſome time after, might be bent, or folded like leaves of paper, but afterwards harden'd in the air. Mineraliſts, and credible authors, mention ſeveral places as abounding with marcaſſitical foſſils; but I am apt to think, they are far more common than is vulgarly taken notice of: for I have met with them where one would little expect them. And, tho' in *England* all our vitriol be made of vitriolic ſtones, or bodies that paſs for ſtones; yet that is not true which our mineraliſts thence conclude, that there is no other vitriolic or marcaſſitical matter in *England*; for a famous dealer in foſſils, having found a mine, which he knew not what to make of, addreſſing himſelf to me, I diſcover'd it to be a vein, that lay at ſome depth under ground, and ran along like a vein of metalline ore, conſiſting of a black and heavy matter; which, upon a few eaſie trials, I quickly found to be ſo far of a vitriolic nature, that, to my wonder, it yielded in a few hours, plenty of pure vitriol, without any troubleſome or artificial preparation.

P R O P. II.

It is probable, that, in ſeveral places, ſome endemical diſeaſes, principally, or at leaſt in part, depend upon ſubterranean ſteams.

By endemical diſeaſes, I do not only mean ſuch as are very peculiar to this or that country; as the *Plica* is ſaid to be to *Poland*, and therefore called *Polonica*; or an odd kind of colic in one part of *France*, from whence 'tis termed *Colique de Poitou*; but alſo thoſe that rage more in ſome countries than in moſt others, as agues in *Kent*, and in that part of *Eſſex* they call the *Hundreds*; the conſumption in *England*; and fluxes of the belly in *Ireland*, where they are ſo common, as to paſs under the name of the country diſeaſe.

That theſe endemical, or local diſtempers, in many places proceed from ſome exceſſive heat, moiſture, or other manifeſt quality of the air; from bad diet, vulgar intemperance, and other cauſes that have little or no connexion with ſubterranean reeks, I readily grant; but, that in ſome places they may either be principally cauſ'd, or much fomented by noxious effluvia, I am inclin'd to ſuſpect.

For, 1. There are ſome places, in which the endemical diſeaſe cannot be probably imputed to any manifeſt cauſe; ſince it often happens, that the cauſes aſſign'd of them, if they were true, muſt produce the like diſtempers in many other places, where yet it is notorious that they are not endemical.

MEDICINE.

2. Subterranean bodies may send up large steams, of different kinds, into the air.

3. The materials that send up these effluvia may be of a large extent. I have sometimes observed, and that in more countries than one, a whole tract of land abounding with minerals of one kind; and at no great distance from it, another large tract, whose subterranean part abounded with minerals of a very different sort.

4. 'Tis, also, highly probable, from the nature of the thing, that those large steams which impregnate the air, may greatly conduce to make it hurtful to a human body, in a way requisite to produce a determinate disease. And, some parts of the substance of the air, not only affect human bodies, or, at least, many individuals among them, as they are taken in by respiration, but as they outwardly touch the skin: and the skin being full of pores, perhaps of different sizes and figures, those corpuscles that get in at them, may have their operation, even upon the most inward parts of the body.

'Tis obvious that I here take the air in its more vulgar and lax signification, for the atmosphere, which abounds with vapours, exhalations, and, in a word, with corpuscles of all sorts, except the larger kind of springy ones; and many of them may be so small, and solid, or so conveniently shap'd, as to enter some of the numerous orifices of the minute glandules of the skin, or at other pores of it. Thus, tho' paper be not pervious to the uncompress'd elastic parts of the air, yet it may be easily penetrated by other corpuscles of the atmosphere: for, I have prepared a dry body, out of a substance belonging to the animal kingdom, which being wrapp'd up in paper, would, without wetting or discolouring, or any way sensibly altering it, pass in a trice thro' the pores of it in such plenty, as to exert a manifest operation on bodies placed at some distance from it. And, tho' a bladder almost full of air, having its neck well tied, be held near the fire in various postures, the elastical air, tho' rarified, or attenuated by the heat, will rather burst the bladder, than get out at its pores; yet we have often prepared a certain substance, belonging to the mineral kingdom, that, if a bladder were wet or moist, would readily pervade it, and have a sensible effect even upon solid bodies placed within it: yet the bladder of urine consists not of a single membrane, and is, probably, of a stronger texture, than many other membranes of the body, or the epidermis. But it may be said, 'tis scarce conceivable, that in so many ages as endemical diseases have afflicted some countries, the subterranean matter, to which I, in great measure, impute some of them, should not be spent and exhausted. And, perhaps, indeed, some diseases may have ceased, in places where they were once endemical; and others may have appeared in their stead. Tho' 'tis very possible, that many subterranean bodies, which emit effluvia, may have in them a kind of propagative or self-multiplying power; proceeding from some seminal principle, or something ana-

analogous to a ferment; or else some maturative property, whereby an inanimate body may gradually admit of such a change, or acquire such qualities, as seem perfective of it, and, perhaps, give it a new denomination. MEDICINE.

But we know nothing of the nature, or constitution, of the lower part of the terrestrial globe; and but little, experimentally, of what lies beneath that very thin crust, to which human industry has been hitherto confined. Whence it is not absurd to suspect, that from the lower subterranean regions, there may be, either continually, or periodically, emitted into the region of mines, great plenty and variety of mineral exhalations, which continually repair the loss of those, that, from time to time, ascend out of the fossil region into the atmosphere.

But farther, bodies so heavy, and consequently so abounding in parts of solid matter crowded together, as minerals, and other fossils, may well be suppos'd capable, without great wast, to emit numerous such minute particles as effluvia, for an exceeding long time. 'Tis surprizing, how long some load-stones, sever'd from their mine, have been kept in the air, without any sensible diminution of their virtue. An eminent physician, who was skill'd in perfumes, affirm'd to me, that an adventitious perfume, introduced, by art, into a silver watch-case which he usually wore, continued to be well scented for sixteen years. The same person had a way of perfuming factitious marble quite thorough, whose grateful scent he affirm'd would last exceedingly; and of this perfumed marble he presented me a ball.

We must, also, observe, that subterranean effluvia may contribute to endemical diseases, not only as they vitiate the air, but as they impregnate or deprave the aliments: for, they mix themselves with the water, which either men drink, it self, alone, or make into factitious liquors. And that many waters are imbued with mineral corpuscles, may be judged by some of the medicinal springs: for, tho' several *Acidula* and *Therma* afford a large quantity of palpable sulphur or salt, yet all do not; and having purposely examined a famous spring, I could, with a pair of nice scales, scarce discover any sensible difference between the medicinal water, and the common water that was to be met near the same place. And that which impregnated this, and which I found by trial on my self, enabled it to work very manifestly like a mineral water, was a sort of corpuscles so minute and subtle, that if the bottles were not kept well stop'd, they would in a short time vanish, and leave the liquor dispirited. Experience has assured me, that there are ways of making common water violently and noxiously operative upon human bodies, tho' its sensible qualities would not make one suspect any change in it. How little change is made in water, and some other liquors, that are render'd strongly emetic by *Crocus metallorum*, and by antimony vitrified without addition? And if such exhalations as arise from the *Averni*, should, as they well may, meet either with running, or stagnant waters, in their ascent, there

MEDICINE. there is little doubt but they will impregnate them, and make them noxious.

But the effluvia of the lower parts of the earth, may have a greater share in producing endemical diseases, by mixing with the water, and other liquors, that are necessary to the nutrition and growth of vegetables, which may thence become unhealthy aliment. And these noxious exhalations will, probably, in many places, impregnate the juices of the earth, much more than running or stagnant waters; because the difficulty of pervading the earth in their ascent, may so long check them, as to render them very numerous in a small space; and, perhaps, make them convene into bodies, so far of a saline nature, as to be soluble either in common water, or some other subterranean liquor; by means whereof, as vehicles, they may insinuate themselves into the roots of plants, and be thence conveyed to other parts. A famous chymist, who liv'd in a country abounding with mines of vitriol, told me, he observed, that the oaks growing over them were remarkably more solid and heavy, than those trees elsewhere are. And the parts of some minerals are capable of insinuating themselves very plentifully into the pores of growing vegetables, without being really subdued, by what the philosophers call the concocting faculty of the plant; whilst, instead of being assimilated by the vegetable, they retain their own mineral nature; and upon the recess, or evaporation of the juice that served them for a vehicle, may sometimes discover themselves to the naked eye. For, I have seen a piece of a vine, that grew not far from *Paris*, which being broken, a multitude of the internal pores of the root, and part of the trunk also, appeared to be stuffed with corpuscles of a marcasitical nature; as was plain by their colour, their shining lustre, and by their weight.

And since men feed not upon either beasts, or birds of prey, but upon such as eat grass, seeds, or other vegetable substances, and drink nothing but water; the noxious exhalations that render vegetables and water unwholesom, may, by that means, have a very bad influence upon such animals, as are fed with such depraved vegetables, and drink such noxious waters; and, consequently, may be very hurtful to those men who eat such animals; and, by the depraved aliment they afford, determine them to that endemical disease, which such vitiated nutriment is fitted to produce.

'Tis possible, also, that in certain places the latent minerals may be of such a nature, that their effluvia, instead of promoting, hinder the production of some particular disease, whether epidemical, or endemical, in the bodies of the inhabitants. For, as physicians observe, that the more manifest morbid causes of some distempers, are quite contrary to those of others; so it seems not improbable, that there may, also, be a mutual contrariety between these latent morbid causes, sent up by subterranean agents. And, therefore, it's no wonder, if some of these should either disable such to which they are hostile, or should,

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at least work in human bodies a great indisposition to admit their hurtful operations. And since there are several whole countries, or less places, that are either altogether, or in great part, free from this or that particular disease; as several parts of *Scotland* from agues, especially quartans; and as in several large regions of the *East-Indies*, the plague is very rare; it seems not improbable, that the subterranean steams may contribute to this advantage, by impregnating the air, the earth, and the water, with corpuscles of opposite qualities to these diseases. And this seems the more credible, because it has been observed, that some vast tracts of land will neither breed, nor maintain venomous creatures; as is undoubtedly believ'd of the whole kingdom of *Ireland*; where, I confess, I neither did see any alive, nor met with such as had.

P R O P. III.

Many epidemical diseases are, probably, in great measure, produced by subterranean effluvia.

It seems probable, that several of those sudden morbid excesses, that are observed in the air, may proceed from the unusual quantity of hurtful exhalations, which ascend and mix with the air, and diffuse themselves through it. We are great strangers to the subterranean part of the globe we inhabit; and there are a great many odd and surprizing things to be met with, in the structure and disposition even of those parts of the earth, that lie but a little way beneath the surface of it. Whence it seems possible, that, among the many and various effluviating bodies, that the terrestrial globe may conceal in its bowels, there are some, whose reeks, ascending plentifully into the air, occasion in it an excess of heat, cold, moisture, thickness, or some other manifest quality. So that, sometimes, even those manifest intemperatures of the air, to which an epidemical disease is wholly imputed, may, in part, proceed from subterranean bodies; for these, by their conflicts, or mutual actions on one another, may excite great and sudden heats, and, on that account, send up such large steams into the atmosphere, as may there produce sudden and excessive heats, lightnings, thunders, &c. And sudden and unseasonable refrigerations of the air, may proceed from the action of subterranean bodies upon one another; for trial, purposely made, has informed me, that there are certain minerals, whereof some may be employed in their crude simplicity, and others that require but a slight preparation, such as may be had in the bowels of the earth, which being put together, will produce, by their re-action, an intense degree of actual cold.

The changes of the air which produce epidemical diseases, are sometimes so great and sudden, that they cannot, in my opinion, with

MEDICINE. probability, be imputed to the action of the sun, or the moon; causes that act in too general and uniform a way, to produce those particular and irregular effects; but to subterranean bodies, whose actions are often more sudden, impetuous, and irregular. The difference we find in seasons, that bear the same name, and should be alike in temperature, is often very great, and, sometimes, also, very lasting. But the sun being in the same signs, at the same times of the year, it does not appear, how he should produce so great a disparity of the temperature of the air, in seasons of the same denomination. And, doubtless, this variety is more rationally attributed to subterranean exhalations, than to the influence of the fixed stars, which are so vastly remote from us; and seem too general a cause to produce such particular effects as are often confined to a town, or some other narrow compass; whilst subterranean bodies are near at hand, of very various natures, and subject to many irregular and differing motions, commixtures, reactions, and other alterations. I have known a great cold, in a day or two, invade multitudes in the same city, with violent and fatal symptoms; when I could not judge, that the bare coldness of the air could so suddenly produce a disease so epidemical and hurtful: and it appeared the more probable, that the cause came from under ground, because it began with a very troublesome fog.

That there may be many subterranean bodies, which, by their mixtures, would produce a sudden heat, will be easily granted by those who know, that there are subterranean menstruums; and have seen chymical operations, such as the great effervescence, made, when oil of vitriol is put upon filings of iron, or spirit of nitre upon butter of antimony, &c. And as there is in many places vast plenty of marcasitical matter, beneath the surface of the earth, and sometimes very near it; I have purposely tried, that by putting a little spirit drawn from nitre, with which salt the earth in many places abounds, or a little oil of vitriol, upon powder'd marcasites, there presently ensued a strong re-action between the liquid and the solid bodies, whereby was produced much heat, with visible fumes, and strong scented exhalations. And such kind of odorous effluvia were emitted, after putting a little spirit of salt upon our powder'd marcasites. And because sulphur is a mineral plentifully met with in the bowels of the earth, and in many places there; I shall add, that I have found acid spirit of sulphur to work sensibly upon marcasitical matter, hard coagulated. An experienced *German* chymist relates, that in some parts of his country, he met with vitriol-stones, or marcasites, that, by the action of mere common water, resting for a competent time upon them, will grow so hot, as to enable the liquor to retain a sensible heat, when it had pass'd a pretty way from them. And, as many accidents may occasion the breaking out of waters, or the change of their course in subterranean places; so, that common water may, in a very short time, produce considerable degrees of heat in mineral bodies, appears by
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mixing with two or three pounds of fine powder of common brimstone, a convenient quantity of filings of iron; for this mixture being thoroughly drench'd with common water, will, in a short time, grow intensely hot, and send out a thick smoke, like that of good quick-lime, whilst 'tis flaked with water.

MEDICINE.

A domestic of mine, who liv'd in the north of *England*, assured me, that in a certain mineral groove, which he had often occasion to resort to, the damp would annoy the workmen more than once in one day. And from others, conversant in mines, I learn'd, that in several places, they were infested with damps, that came not at stated periods, but irregularly; sometimes with much greater, and sometimes with far less intervals between them: the times of their duration being also often unequal. So that, supposing such noxious effluvia to be plentifully emitted from the lower parts of the soil, it need be no wonder, that an epidemical disease should rage in a particular town, or part of a country, without spreading much farther; and that it should begin suddenly in places where it was not expected: for, these swarms of effluvia being produced by casual concourses of circumstances, may often be excited, and invade this or that place, without giving the inhabitants any warning. And 'tis not always necessary, that such noxious effluvia should be generated just under the places they molest; since the motion of the air may suffice to carry them to the town or other place that feels their ill effects: and yet they may seem to be almost confin'd to those places; sometimes, because the neighbouring parts are not sufficiently inhabited to make their ill qualities taken notice of; but more frequently, because, by being diffus'd thorough a greater tract of air, they are more dispers'd in their passage, and thereby so weaken'd, as not to be able to do any considerable mischief.

Nor is it always necessary, that the harm done by these morbid constitutions of the air, should proceed only from subterranean exhalations, merely by virtue of their own qualities, which they bring with them from under-ground. For, 'tis very possible, that these effluvia may, in their own nature, be either innocent, or at least not considerably hurtful; and yet become very noxious, if they chance to find the air already imbu'd with certain corpuscles fit to associate with them: for, tho' these sorts of particles were, perhaps, neither of them, a-part, considerably prejudicial, yet there may from their combinations result corpuscles of a new and very morbid nature. Thus the spirituous steams of salt-petre do not usually sensibly work on gold, no more than the spirituous parts that the fire raises from sal-armoniac; yet, when these two sorts of particles unite, there will result certain corpuscles of a new nature, that compose the liquor call'd *Aqua regis*; which by its fretting quality corrodes and dissolves gold.

And as this liquor, being at once poured upon silver, gold, diamonds, rubies, &c. will leave all the rest uncorroded, and fall only upon

MEDICINE. the gold; so, the new corpuscles produced in the air, whether attracted in respiration, or entering in at the pores, being carried up and down by the blood, or other fluids of the body, may pass by some parts without doing them any sensible harm, and attacking others, there produce some disease, such as the fabric and situation of the part peculiarly dispose it to admit.

And this hypothesis of ours well agrees with the very short duration of some epidemical diseases, in certain times and places. For either all the morbidic exhalations ascended into the air at once, or, at least, in a short space of time, and so were easily spent; that is, by being diffused or dispersed, too much weakened to do any great mischief; or else the subterranean commotion that produced them may pass on from one place to another, and so cease to afford the air incumbent on the first place, the supplies necessary to keep it impregnated with noxious exhalations. Thus we sometimes observe certain epidemical diseases to have, as it were, a progressive motion, and leaving one town free, pass on to another.

And as sometimes an epidemical disease ceases in a particular place almost as suddenly as it invaded the same; so, according to our hypothesis it may well happen, that after one sort of exhalations, whose peculiar qualities make them morbidic, have deprav'd the air over a particular place; there may, by a new or farther commotion of subterranean bodies, be sent up large exhalations of another kind, which meeting with those that formerly impregnated the air, may either precipitate them, and so free the air from them; or by other operations, and sometimes even by coalitions, so alter their nature, as to disable them from doing any farther mischief.

Thus in that very remarkable phenomenon, yearly observ'd at *Grand Cairo*, it appears, that by the intermixture of adventitious corpuscles with the pestilential air, this is so alter'd and corrected, that within one day or two, there is a stop put to the progress of the plague, which, about the middle of summer, scarce ever fails to rage in that populous city. And these friendly corpuscles operate so powerfully, that of those who are already seiz'd by the plague, few or none die, after once the air is sufficiently impregnated with them.

I confess so great and sudden a change is very surprizing; and I should scarce think it credible, had not several persons, some of them very intelligent, who made a considerable stay in that city, assured me of the truth of it. And the latest writer of voyages into *Egypt* relates, that a little after the middle of our *June* (and usually upon the very seventeenth day) there begin to fall, towards the last quarter of the night, certain drops of a kind of dew, which causes the river to be fruitful, and purifies the air from all infection. He adds, that "the dew purifies the air; for as soon as it falls, the plague ceases to be mortal;" and, he says, "this dew gives life to every thing; and when it falls upon
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“ the wheat, causeth it to continue for many years without corruption, MEDICINE.
 “ or worms ; and renders it far more nourishing than that corn on which
 “ it never falls. And, therefore, they never house the corn of the grand
 “ seignior till this dew is fallen upon it.”

On the other hand, a very ingenious gentleman, who was owner of some mines in *Devonshire*, told me, it sometimes happens that, of a sudden, a considerable tract of ground will be as 'twere blasted by the ascending fumes ; so that not only the grass, fern, and other more tender vegetables, will be turned black, and, as it were, burnt or scorched up ; but now and then trees also, and even oaks themselves, will be blasted and spoiled by the powerful operation of these subtile and poisonous effluvia.

'Twill be expected I should here take some particular notice of pestilential fevers and the plague. The former, indeed, may probably arise from noxious effluvia of the earth : but as for the true plague, I am at a loss for its origin ; however, its propagation and effects seem chiefly to be carry'd on by a malignant disposition in the air ; without which, some plagues could never have been so contagious, nor so suddenly mortal : and that this malignant disposition in the air, may, probably, be in great part imputed to some kinds of subterranean exhalations, I am apt to think, for the following reasons.

The propagation, effects, and phenomena of the plague.

And first, none of the several causes to which the plague is usually imputed, seems sufficient. The malevolent aspects and influence of the celestial bodies suppose some things very difficult to be prov'd, and are agents too remote, too general, and too indeterminate, to be acquiesc'd in as the causes of such particular symptoms and phenomena, as often accompany the pestilence. And as for internal putrefaction, excessive heats, noisome smells, corrupt aliments, &c. the learned *Diermerbroeck*, tho' his own hypothesis seems to be more theological than philosophical, has greatly weaken'd their force in this case.

But farther, by consulting some uncommon authors, travellers, and navigators, I learn, that several great countries are usually free from the plague ; which, according to the vulgar hypothesis, ought to be as much subject to it as others. *Leo Africanus* informs us, that some parts are so seldom afflicted with the plague, that it usually spares the inhabitants for twenty-nine or thirty years together. And he expressly records, that in *Numidia* it self, notwithstanding the raging heat of the climate, the plague is produc'd but once in a hundred years. Our *Purchas* informs us, that in the land of the *Negro's*, it is not known at all. And, to omit what some travellers and navigators relate of *Japan*, as if it were seldom or never invaded by the pestilence ; I do not remember, that in *New-England*, which contains a great extent of land, that the *English* take any notice of the plague, since their first settling there. Sir *Philibert Vernatti* writes from *Batavia*, “ that the plague is a disease unknown to the *Indians*.” And of the countries that I've yet more remote, as the great empire of *China*, and the kingdoms of

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MEDICINE. *Turquin*, and of *Cochinchina*, *Alexander de Rhodes*, who spent thirty years in those parts, affirms, that the plague is not so much as spoken of there; yet the same jesuit, upon probable grounds, estimates the number of the people of *China* alone, to be two hundred and fifty millions; a number I take, by far, to exceed that of all the Nations of *Europe*.

Now considering what vast tracts of land are compriz'd in those countries, some of which the plague does not at all, and others but very unfrequently, invade; we have a strong argument against the generality of opinions received among physicians; as also that of *Diemerbroeck* himself, who derives the plague from a supernatural cause, the provok'd wrath of God. For, in regions of such extent, and many of them very populous, lying in different climates, and some of them inhabited by nations who make war with numerous armies, fight bloody battels, leave heaps of unburied bodies exposed to the putrefying heat of the sun, are sometimes forc'd to live upon very unwholesom foods, who worship stocks, stones, beasts, and some of them devils, who are, at least, as guilty as *Europeans*, of assassinations, poisonings, rapes, &c. in these regions; I say, 'tis not imaginable but that great intemperatures of the air, especially in point of heat, stench of dead bodies kill'd in fights, unwholesomeness of aliments, malevolent aspects of celestial bodies, high provocations of the divine justice, and, in short, all the causes, to one or other of which the several parties of physicians refer the plague, should be wanting any more than in *Europe*; yet the plague, which is presum'd to be the effect of one or other of those causes, is not here observed to be produc'd.

If these historical facts be alledged, also, against our hypothesis, I desire it may be consider'd, that my opinion about the plague consists of two parts; one, that 'tis exceeding difficult to assign the true and adequate cause of its origin; and the other, that whatever be the cause of its first eruption; its propagation, and many of its symptoms, may be, probably, refer'd to the depravation of the air by subterranean steams, and their effects: whence, these historical observations will appear to confirm the first member of our hypothesis. And as to the second; since in the *East-Indies*, and other countries, where the plague is not observed to break out, it cannot be pretended, that subterranean effluvia there promote the propagation of it; no more can it be prov'd, that they could not, in case the plague were begun by other causes. But as I think it probable, that sometimes the plague is not only fomented, but begun by noxious exspirations of the terrestrial globe, I shall add, that this supposition is not absolutely inconsistent with the preceeding observations. For first, it may be said, that some of the countries I speak of, are destitute of those noxious minerals to which we impute some plagues. Thus tho' sulphur be usually found in many countries, and that in plenty, where there are other metalline veins, yet in the mines of *England*, I never met with

so much as an ounce of native sulphur; and I could not find that several MEDICINE. mineralists, of whom I purposely inquired, had met with any, among the various mines they had frequented. There may, also, happen to be noxious minerals in a country, that are not often capable of producing or promoting pestilences there, even upon moderate earth-quakes. For, 'tis possible, that these orpimental, or other noxious minerals, may have their beds, or veins so deep in the earth, that they are not ordinarily able to send up effluvia, strong and plentiful enough to make a pestilential depravation of the air; and, in lesser earth-quakes, the commotion or agitation of the ground, may not reach so far downwards, as much to affect these very deep mines; and yet some other more violent shocks may affect even these: whence one may give a tolerable account, why the plague in some parts of *Afric*, has been observed to rage but once in thirty, or once in an hundred years; for there may be periodical paroxysms, or grand and vehement commotions, in subterranean parts, tho' men have not yet observed them. A late judicious *French* historian records, that a very pernicious disease, of the nature of a colic, reigned in *France*, every tenth year, for a long tract of time. And *Platerus* relates, that at *Basil*, where he practised physic for fifty six years, the city was afflicted with furious plagues, once in about every tenth year, for seventy years together. It may farther be said, that those exhalations in the *East-Indies*, &c. which wou'd otherwise be pestiferous, may be corrected by other expirations, either of a benign nature, or of such an one, as, tho' noxious in themselves, may fit them, by combining with the others, to disable and prevent their ill effects; as *Beguinus* tells us, that a country abounding in veins and masses of cinnabar, which is the ore of quick-silver, was preserved from the plague, when the neighbouring regions were wasted by it. And tho' corrosive sublimate be so mischievous a mineral composition, that a few grains may kill a man; yet the fumes of this combined with those of crude, common quick-silver, which are themselves unwholesom, make *Mercurius dulcis*, an useful and innocent medicine.

It might, likewise, be alledged, that in such regions, the soil, and other assistant causes, may constantly produce in the air a constitution like that in the air of *Egypt*, during the time of the increase and overflowing of the *Nile*; which usually lasts every year for several weeks; during which time, the air is wholly anti-pestilential.

Our conjecture, also, will afford a probable account of some considerable things, relating to the production and phenomena of the plague.

'Tis observed, that sometimes the plague breaks out, when no immoderate disorder of the air, or any casual enormity, capable of producing so great and irregular an effect, has happen'd. Nay, it has been observed, that very great and unusual intemperatures of the air, have often happen'd, and many notable and threatening aspects of the stars, without being followed by the plague. *Fernelius* relates, that

MEDICINE. that the year, which of all in the memory of man, was all the world over the most immoderately hot, yet proved most healthful. And the same author reports the plague to have begun in the midst of winter, and to have gone off in summer; and that, several times, scorching summers have been altogether free from the plague; which I, likewise, have observed to be true. *Johannes Morellus* tells us, that in his country, after a dry winter, wherein the north wind reign'd, tho' it were succeeded by a most temperate and healthful spring, yet this brought in the plague; and that too, when the north wind was predominant, and the air pure and serene. And I observed something very like it, in the constitutions of the air, that preceded and accompanied the dreadful *London* plague in the year 1665. Now, these phenomena much discredit their opinion, who impute the plague to the excesses of the manifest qualities of the air; but are agreeable to our hypothesis, since noxious subterranean fumes may be suddenly, and without any warning, raised up into the air; and, by depraving it, produce fatal diseases in many of those persons who are constantly surrounded by it, and draw it in, almost every moment, with their breath.

Of the deadly effect of several subterranean expirations, at their first eruption, there are many histories extant in approved authors: and we have observed instances of that sort, in the times and countries we live in. But, because all poisonous, and even mortal exhalations, are not, therefore, truly pestiferous, but may, like many other poisons, kill the persons they immediately invade, without qualifying them to infect others; I shall add a passage out of *M. de Mezeray*, who relates, that "the plague which happened in *France*, in the year 1346, was so contagious, that scarce a village, or even a house, escaped uninfected by it. This pestilence," he says, "was the most furious and wide-spreading that had been known, and began two years before in the kingdom of *Cathay*, by a vapour most horribly fetid, that breaking out of the earth, like a kind of subterranean fire, consumed and devoured above 200 leagues of that country, even to the very trees and stones; and infected the air in a wonderful manner." He adds, that "from *Cathay*, it pass'd into *Asia* and *Greece*, thence into *Afric*, and afterwards into *Europe*, which it ransack'd throughout."

In the next place; there is a wonderful diversity observed in several countries, and even in the same country, at different times of those raging diseases, that physicians call the plague; whence it happens, that such medicines, or methods of cure, as are in one plague successful, do often in another prove dangerous: which great variety may be fairly accounted for, by the great number and diversity that has been actually found, or may be reasonably suppos'd, in the numerous minerals, and other bodies, in the subterranean regions; especially if we consider, that the number of such bodies may be much increased and diversified, by various combinations made of them by casualties, subterranean fires, and menstruums. And the ascending corpuscles of those
mineral

mineral bodies, being most of them solid and subtile, may produce in MEDICINE. the blood, and so in the body, far more odd and violent symptoms, than the peccant humours that beget ordinary diseases. Which may be one reason, and perhaps the chief, why the ancients, and *Hippocrates* himself, acknowledged in pestilential diseases, somewhat of divine, surpassing ordinary nature.

What these mineral substances are, whose steams produce such odd and dismal symptoms, seems exceeding hard to determine. Yet, if I were to name one sort, I should think the least unlikely to be orpiment. For, of the poisonous minerals we are acquainted with, I know not any whereof there is a greater quantity in the bowels of the earth; many of whose mischievous effects seem to agree with the symptoms of some plagues, and may be guessed to have, at least, a considerable share in producing them. Yet I do not think that these minerals are the causes, even of all those pestilences, whose efficient may be subterranean: for several reasons, and some drawn from experience, make it probable, that the subterranean regions have many kinds of very pernicious fossils, of which physicians, and even chymists, have no knowledge, nor distinct names; and that the various associations of these, which nature may by fire and menstrua make under ground, and, perhaps, in the air it self, will very much increase the number and variety of noxious materials, and also heighten their hostility to human bodies. Thus, the factitious white arsenic, commonly sold in shops, tho' usually made of orpiment, by the addition of so innocent a body as common salt, (which is found in great plenty under ground) is observed to be far more poisonous than orpiment it self. And a skilful chymist, having in my presence, tasted some prepared arsenic, was quickly invaded by such symptoms, as he thought would soon kill him. But I presently put him out of danger, tho' not out of pain, by early prescribing him plenty of oil of sweet almonds, and something made of lemons, that I chanced to have by me. And sandarach seems to be but orpiment, whose yellow colour is deepned to redness; as native arsenic seems to be little other than pale or white orpiment. And, indeed, in *Hungary*, all three may be found not far from one another, in the same mine; as I learn'd from an eye-witness, by whose means, and those of another chymist, several native orpimental minerals, (to say nothing of realgar, because it is a factitious combination of orpiment and sulphur) came to my hands. But tho' this sort of fossils are more numerous and various than is vulgarly observed, yet the very noxious effects of the effluvia of orpiment, are not unknown to physicians: and the learned *Sennertus* gives a particular instance of it in a painter, who, upon opening a box where orpiment, which men of his profession use as a pigment, had been long kept, was thereby cast into fainting fits, and had his face much swell'd. And, as white arsenic is of a more piercing and corrosive nature, so it were easy to shew, out of the writings of eminent physicians, that its effects have

MEDICINE. often proved very hurtful, and sometimes mortal, tho' but externally worn in amulets; especially if the pores of the skin were opened by exercise and sweat. And the nature of the symptoms produced, seems to confirm our hypothesis; since the persons who wore these arsenical amulets were affected, some with great anxieties about the heart, some with inflammation, some with burning fevers, some with exulcerations of the breast, some with pustules, like those of the plague; and these were sometimes black, as if made with a caustic. Most patients of this kind were affected with great weakness and faintness, &c. as if they had swallowed poison; and of one young man 'tis recorded, that having heated himself in a tennis-court, with an amulet upon his breast, the virulence of its corpuscles made him fall down dead upon the spot. And 'tis a considerable circumstance in these observations, that several patients were cur'd of the symptoms, that seem'd pestilential, by the same remedies that are alexipharmic against the plague; whence it may, also, be made probable, that the plague it self, many times, is a natural, tho' a dreadful and irregular disease; since its effects and symptoms so much resemble those of acknowledged poisons, and have been cured by antidotes effectual against them.

An ingenious man, who sometimes visited a mine known to abound with orpimental fossils, told me, that when he walked over the neighbouring grounds, he found himself much disordered, especially in his thorax, by the effluvia; and that the mine-men and diggers were subject to a malignant, irregular, and dangerous sort of fevers; tho' he said he was apt to impute it, in some measure, how truly I know not, to their drinking too much strong wine. But, tho' 'tis probable, the effluvia of orpimental bodies may have a great interest in several plagues, yet, I strongly suspect, that many others may proceed from the steams of such subterranean bodies, as are not yet distinctly known to us; and, possibly, have their effluvia variously combined, either beneath, or above the surface of the earth. I have several times, and that without heat, combined fumes of differing kinds, separately invisible, into manifestly visible ones, in the free and open air.

And that the subterranean effluvia may produce effects, and, therefore, probably, be of natures very uncommon, irregular, and exorbitant, appears from those prodigious crosses that were seen in the year 1660. in the kingdom of *Naples*, after an eruption of *Vesuvius*. For these crosses appear'd on linen that had lain open to the air; because, as *Kircher* fairly conjectures, the mineral vapours were, by the texture of that, easily determined to run along in almost strait lines, cutting each other; and, consequently, to frame spots, resembling some one, and some other kinds of crosses. These were extremely numerous in several parts of the kingdom of *Naples*; whence the jesuit, who sent the relation to *Kircher*, says, that he himself found thirty in one altar-cloth; that fifteen were found upon the shift-sleeve of a woman; and that he reckoned eight in a boy's hand: Their colour and magnitude were

were also very unequal, and their figures different; they would not wash out with simple water, but required soap; their duration was likewise unequal, some lasting ten or fifteen days, and others longer, before they disappear'd. And these crosses were found not only upon linen garments expos'd to the air, but upon some of those that were kept lock'd up in chests.

A pious and learned school-master, who ventured to stay in *London* during the great plague in 1665; and was much employed to visit the sick; and went indiscriminately to all sorts of infected, and even dying persons, assured me, that being once called to a poor woman, who had buried some children of the plague, he found the room so little, that it scarce held any more than the bed whereon she lay; and an open coffin, wherein he saw her husband lie dead of the same disease, whom the wife soon after followed. In this little close room, 'twas affirmed to him, that the contagious steams had produced spots on the very wall. He also declared himself to have observed the like in his own study, which being divided only by a wall, from some rooms of a house, which the owner had turned into a kind of a pest-house, and in which numbers had died in a short time; he took notice that the white wall of his study was (since the sickness raged) blemished in several places with spots, like those of infected persons. Inquiring what antidote he us'd against the infection, he reply'd, a spoon-full of brandy, five or six times a day, especially when he went into infected places, and a small piece of the root of *Spanish* angelica, which he held in his mouth as often as he thought necessary.

But tho' I fear physicians will not be able to discover all the subterranean bodies, whose effluvia produce or contribute to the plague; yet I do not think it impossible, that by diligent observations and trials, sagacious men may discover several of them; and, perhaps, antidotes against them.

In the late great plague, that swept away so many thousands at *London*, there remained in the city an ingenious physician, bred by the learned *Diemerbroeck*, and who twice had the plague himself, whereof he shew'd me some effects; and told me, that notwithstanding many and various trials, he still found abundance of his patients die, after the buboes, carbuncles, or pestilential tumours appeared; because, upon a little refrigeration of the body by the air, and often by the very fear that disheartned the patient, the tumours would suddenly subside; when the pestilential matter, recoiling upon the vital parts, would quickly dispatch the fatal work. He therefore bethought himself of a method, by means of which he assured me, he had not lost one patient of very many he treated; if he could but, as he usually did, by good alexipharmic and cordial remedies, enable and excite nature to expel the peccant matter into a tumour; for then he presently clapp'd on an appropriated drawing-plaster, which would never suffer the tumour to subside, but break it, or make it fit for opening, and thereby give nature

MEDICINE. a convenient vent, at which to discharge the matter that oppress'd here. This plaister was no other than the *Magnes arsenicalis* of *Angelus Sala*, mixt up with the warm gums. And if it prove as successful in other plagues, as it did to those who us'd it in that of *London*; there will be just cause to admire the providence, which, in a poisonous mineral, that, probably, often concurs to produce the plague, has laid up a remedy for it.

An ancient and very experienc'd physician, to whose care a great pest-house was committed, where, by the contagion, he lost three physicians, his assistants, and three chirurgeons of four who were under him, told me, that his constant antidote was, only to take every morning, fasting, a little sea-salt dissolv'd in a few spoonfuls of fair water.

And a very learned physician, having once recommended to me an herb, little noted in *England*, as a most effectual and experienced antidote against the plague, I caus'd it to be cultivated in a garden, and when the pestilence raged most severely in *London*, I sent some of it, made up with a little sugar, in the form of a fine green conserve, to two infected persons, who, both of them recover'd. But having made only those two tryals, I dare not relie much upon them; however, I usually keep the plant growing in a garden, because both the tast and colour are pleasant; and because some little experience has invited me to believe the commendations I have found given of it against the bites of venomous creatures: about which there is a notable instance recorded by *P. Spehrerius*, of a *Roman*, who having, with his staff, crush'd a viper that he took to be dead, had so strong a venom transmitted along the staff to him, that on the ensuing night, he found a very great inflammation in both his lips, which was followed by a vehement burning fever, and strange torture; from all which he was strangely relieved by the juice of goats-rue. It may without disgust be taken plentifully, in its entire substance, in the form of a salad, a conserve, or, a syrup, or else in its juice, newly express'd.

It, likewise, agrees with our hypothesis, that sometimes the plague ceases, or at least greatly abates of its contagion and malignity, in far less time than physicians could rationally expect. For sometimes it may happen, that, tho' the constitution of the air continues the same, the matter that afforded the pestiferous exhalations, may be either spent under ground, or altered by combination with other subterranean bodies, or by some of those many accidents that may happen, wholly unknown to us, in those dark recesses. And if once the fountain of these noxious effluvia be stoppt, so that those in the air cease to be recruited; the wind and other causes may, in a short time, dissipate them; or at least dilute them with innocent air, so far as to keep the disease, they produc'd, from being so mischievous as before. And it may often happen, that, tho' the minerals which emit the hurtful

ful expirations, remain where they were under ground, and be not MEDICINE. considerably waſted, yet their fatal effects may not be laſting; becauſe the effluvia were generated by the conflict of two or more of them, which vehemently agitated one another, and ſent up fumes, that ceaſ'd to aſcend, at leaſt in great plenty, when the conflict and agitation ceaſ'd. Thus, by putting good ſpirit of ſalt upon filings of ſteel or iron, in a convenient glaſs, a great conflict will be made between them; and without the help of external heat, there will be ſent up into the air large viſible fumes of a very ſulphureous odour, and eaſily inflammable; and this elevation of fumes will leſſen or ceaſe, as does the tumultuous agitation that produc'd them. So, likewise, if you pour *Aqua fortis* upon a convenient proportion of ſalt of tartar, there will, at firſt, be a great ebullition produc'd; and, whiſt that continues, great, red and noiſome fumes will be elevated, but not long outlaſt the commotion of the mixture, whoſe active parts ſoon combine into a kind of nitrous ſalt, wherein the noxious parts of the menſtrum are clog'd and hinder'd from evaporating or aſcending, tho' really they retain much of their priſtine nature.

It may, alſo, happen, that ſoon after the commotion of ſubterranean matter, which yielded peſtiferous exhalations, a more intense degree of ſubterranean heat, or perhaps the ſame latent fire, extending it ſelf farther, may force up fumes of another ſort, that, being of a contrary nature, may prove antidotal to the former; and, by precipitating them, or combining with them, diſable them from acting ſo miſchievouſly as they otherwiſe would. I have ſometimes purpoſely made diſtillations, in which one part of the matter being, after the operation was ended, put to the other, there enſued a ſudden and manifeſt conflict between them, and ſometimes an intense degree of heat. And that mineral exhalations, tho' otherwiſe not wholeſom, may diſarm peſtiferous effluvia, appears from that obſervation of a country, which abounding with veins of cinnabar, was, probably, by their expirations, preſerved from the peſtilence. And our hypotheſis will, perhaps, appear the more probable, from the ſudden check that is almoſt every ſummer given to the plague, which at that time reigns at *Grand Cairo*. For, ſince 'tis generally obſerved, that morbiſic cauſes operate much more effectually than curative ones; it ſeems very probable, that exhalations aſcending from under ground into the atmosphere, may be able to produce peſtilential fevers, and the plague it ſelf; ſince thoſe corpuscles that impregnate the *Egyptian* air upon the ſwelling of the *Nile*, put a ſpeedy ſtop not only to the contagion, but to the malignity of the plague, aſſiſted even by the ſummers heat, which at *Grand Cairo* is exceſſive.

The Air consider'd,

P R O P. IV.

'Tis very probable, that most of the diseases, which even physicians call new, are caus'd, either principally, or secondarily, by subterranean steams.

The term new disease, is much abused by the vulgar, who give that title to almost every fever, that, in autumn especially, varies a little in its symptoms, or other circumstances, from the fevers of the foregoing year or season. But by new diseases, I mean only such, whose symptoms are so uncommon, that physicians themselves judge them to deserve that appellation; such, for instance, as the *Sudor Anglicus*, or sweating sickness; the rickets, and the *Lues Venerea*. But, perhaps, some diseases, which, even among physicians, have pass'd for new, were extant before, tho' not in the country wherein they are judg'd to be new.

But, taking it for granted, with the generality of physicians, that some new diseases are to be admitted; I do not derive them wholly, or chiefly, from the varying influences of the heavenly bodies. For, the most powerful of those, the sun and moon, act in too general and indeterminate a way, to afford a sufficient account of this matter. And as for the fix'd stars, besides that they are universal and indefinite agents, it seems justly questionable, whether they have any sensible operation upon any part of our bodies, except our eyes. And, tho' I allow that great intemperatures of the air, as to the four qualities, heat, cold, dryness, and moisture, may dispose mens bodies to several great distempers; yet I cannot acquiesce in these, when I consider how much more frequently they happen, than new diseases; and that their action, tho' various, is too general and indeterminate to shew they can be the adequate causes of effects so rare and irregular, as diseases odd enough to deserve the title of new.

But, now, the subterranean region of our globe is always near us, and abounds with variety of noxious minerals, and, probably, conceals great quantities of different sorts of them. And since there want not causes in the bowels of the earth, to make great, irregular, and sometimes sudden confluxes, conflicts, dissipations, and other considerable changes, amongst the materials that nature has plentifully treasured up in those magazines; and since we have shewn, that the subterranean parts of the globe may plentifully send up noxious effluvia of several kinds into the air; it ought not to seem improbable, that among this resulting variety of foreign and noxious steams, some may be found capable to disaffect human bodies, after a very uncommon way, and thereby produce new diseases; whose duration may be greater or less, according to the lastingness of those subterranean causes that produce them. On which account, it need be no wonder, that some new diseases have but a short duration, and vanish not long after they appear; the source or
fomes

some of the morbid effluvia being soon destroyed or spent; whilst MEDICINE: others may continue longer, as having under ground more settled and durable causes to maintain them.

It will, I presume, pass for a strong proof and illustration of our whole doctrine, if we shall shew by experiments, that metals completely formed and malleable, may be elevated into the air, perhaps without any great violence of fire, in the form of exhalations and vapours; the singly invisible corpuscles still retaining their metalline nature.

We took three parts of *Dantzic vitriol*, (which is blue, and partakes of copper) and two of good sea-salt; these, being very well powder'd and mix'd, we distill'd with a strong naked fire, to force out all that could be driven over; whereby we not only obtained a spirit of salt of a manifestly bluish colour, but there ascended, also, a considerable quantity of matter, which being shaken with the liquor, settled at the bottom of it in the form of a powder, judg'd to consist of cupreous and ferruginous corpuscles.

By substituting *English vitriol*, (which is green, and abounds more in iron than that of *Dantzic*) and proceeding in other respects as in the former process, we obtain'd a very yellow spirit, with a considerable quantity of a yellowish powder, that was suppos'd to be a kind of *Crocus Martis*.

We cast very thin plates of copper into a retort, upon an equal or a double weight of good mercury sublimate; and luting on the receiver, gave a gradual fire for several hours: by which means we usually obtained some running mercury, together with some sublimate, that had not fasten'd upon the copper. And, at the bottom of the retort, we had much of a ponderous and brittle substance, that did not appear at all like a metal, but of a gumous or resinous nature; being also fusible and inflammable almost like sealing-wax. This I put into the hands of an industrious physician, who, according to my direction, expos'd it grossly beaten to the free air; where it, in a short time, changed colour, and turn'd to a kind of verdegrease: which being dissolved in good spirit of salt, gave a solution of a very lovely green colour. This being slowly distill'd dry, yielded but a very weak and phlegmy liquor; and the *Caput mortuum* was again dissolved in fresh spirit, and the menstruum abstracted as before. Which process we repeated several times, till the matter was so impregnated, that the menstruum being drawn off from it, came over as strong almost as when it was put on. Then the verdegrease, thus impregnated, was diligently mixed with tripoly, and distill'd with a strong fire; when, it afforded plenty of a colourless liquor, like common water; which made the physician suppose the experiment had miscarried, till having dropt into it some spirit of hartshorn, or of sal-armoniac, he was surprized to find it presently disclose a deep and lovely blue colour. And this may suffice to shew, that corpuscles of copper may be elevated in the form of exhalations, both transparent and colourless.

MEDICINE.

If from good *Cornish* tin, you warily distil an equal or double weight of *Venetian* sublimate, into a very large receiver, very well luted on to the retort, you will obtain a spirituous liquor, which, as soon as the free air comes to touch it, will, very long, send up abundance of white exhalations in the form of a thick smoak: and tho' this liquor be thus apt to emit smoak, not only plentifully, but, as one would think, with violence, yet even when I put it into an open vessel, if I did but lay a piece of a single leaf of paper upon the orifice of the glass, so as to cover it all, the visible production of the fumes would presently cease; and the liquor lie like common water, as long as the paper remained, tho' lightly upon the glass; but upon the removal of that, the liquor would send up plentiful fumes as before: which seems to argue, that some metalline substances may, by the contact of the air, have their copious ascent into the atmosphere very much help'd and promoted, as if the air had saline, or other sort of particles in it, that, with regard to some mineral bodies, are of a very volatilizing nature.

We dissolved copper in good *Aqua fortis*, till the menstruum was satiated with it; in the strong solution, we steep'd, for a while, some brown paper, that being fitter than the finer to soak up the liquor; then slowly evaporating the superfluous moisture, we put a quantity of this imperfectly dry'd paper upon the hearth, at such a distance from a fire of actually flaming wood, that the paper was not kindled, yet so scorched, as to afford very plentiful fumes; which looked like ordinary smoke, whilst they moved through the air. But when the motion of the air towards the flame, had carried these fumes to it, they disclosed their nature; for, being actually kindled, they tinged the flame of a lovely colour, for the most part blue, and sometimes green, as they happen'd to be variously mixed with the flame and smoke of the wood.



T H E
N O T I O N
 O F
Specific Remedies

Prov'd agreeable to
MECHANICAL PHILOSOPHY:

With the advantages of simple Medicines consider'd;
 and their Use recommended.

S E C T. I.

THE specific virtue of medicines, is an occult quality that well deserves our consideration. For, it not only excites our curiosity, and nearly concerns our health; but may, perhaps, prove of much greater importance than is commonly imagined. And an enquiry into this abstruse phenomenon, seems to me the more necessary, because many learned physicians reject the mechanical philosophy for being, as they fancy, irreconcilable to the notion of specific remedies; or, at least, unable to give any tolerable account of their operation.

I find three sorts of qualities mentioned in the writings of physicians, under the notion of specific virtues. By some of them a medicine is said to have a specific quality, because it is eminently and peculiarly beneficial to a particular part of the body, as the heart, the brain, the eyes, &c. Others say, that a specific remedy attracts and evacuates some determinate humour, as choler, phlegm, &c. But the most usual

Specific qualities, what.

MEDICINE. account, upon which a medicine is said to be specific, is, that by some hidden property it cures this or that particular disease; as a pleurisy, an asthma, the colic, dropsy, &c. And this being the principal and most common sense, wherein the word specific is employed by physicians, I shall, hereafter, commonly make use of it in that sense; yet without confining my self so strictly thereto, as not to consider it in the other two, when occasion shall require.

But, before I descend to particular considerations, I previously declare, that by a specific medicine, I do not understand one that will cure a disease infallibly and universally; for, I confess, I never yet met with any such remedy. Nor do I, by a specific medicine, mean one that, like a charm, works only by some latent and unaccountable property, without the assistance of a known quality. But by specific, I here denote a medicine, that most commonly, and better than ordinary means, gives considerable relief to the patient, by acting principally upon the account of some peculiar virtue; so that if it have any benign manifest quality, yet the service it does is greater than can reasonably be ascribed to such a degree of the manifest quality it possesses; whether it prove hot, cold, bitter, sudorific, &c.

*Whether there
be really any
specific virtue
in medicines.*

Two grand questions may be proposed, about the specific virtues ascribed to medicines; as first, whether they really exist; and, secondly, if they do, whether they can be mechanically accounted for.

The former of these questions admits of a double meaning; for it may be propos'd with respect either to the present measure of our knowledge, or to the future attainments of mankind.

In the latter sense, I shall not maintain, without restriction, either part of the question. For I am apt to think, that the future industry and sagacity of men, will be able to discover intelligible causes of most of those qualities, that now pass for occult; and among the rest of many specific virtues ascribed to medicines; yet, on the other side, posterity will not be successful in tracing out the true and immediate causes of those good effects of some remedies, that depend upon too fine and uncommon textures, and too latent and irregular motions, to fall under the senses, tho' assisted by instruments. And this seems the less improbable, from considering those strange peculiarities of disposition in the bodies of particular persons, that are mentioned in the books of eminent writers. Some few of these, indeed, may be plausibly accounted for; yet I do not think the like explications applicable to others.

As to the former sense of the question, I confess my self very inclinable to the affirmative; as far as I can judge by such writings of physicians, as I have perused. This limitation I add, because I wou'd not derogate from the knowledge of particular persons, who may have arrived at far greater attainments, than those who have entertained the public about the occult and specific qualities of medicines.

I know there have been, and still are, dogmatical physicians, who, upon the principles of the school-philosophy, reject all medicinal

vir-

virtues, that they think not reducible to manifest qualities. But of *MEDICINE.* such *Galen* justly complains, that they either deny matter of fact, or assign very incompetent causes of the effects they pretend to explain. And, for my part, I am so far from believing these men capable of giving sufficient reasons of the more hidden properties of medicines, that I think them unable, by their principles, to give clear and particular explanations, even of the more easy and familiar virtues of simples.

I am, therefore, of opinion, that in my sense of the term specific, there are specific remedies. To this opinion I have been led by several reasons. And, first, it has the suffrage of many learned physicians, both ancient and modern, and particularly of *Galen* himself, in several parts of his works; who, treating of a specific for the bite of a mad dog, whose virtue he ascribes to an occult quality; or, as he speaks to the propriety of the whole substance; he takes occasion to promise a discourse upon things, which operate in that manner. And, tho' in matters of philosophy, I am little sway'd by mere authority; yet the concurrent testimony of many eminent physicians, may, in this controversy, be the more considerable, because most of them having been noted practitioners, had opportunity to observe, whether or no any remedies deserv'd the name of specifics. And their testimony is the stronger in this case, because physicians are usually very unwilling to acknowledge, there are effects which fall under the cognizance of their art, whereof they cannot assign the causes.

*Argument
for the ex-
istence of specific
remedies.*

My next inducement to admit specifics, is founded upon parity of reason. For 'tis manifest, that many formidable diseases are produced by inconsiderable quantities of poisons; which have not been discovered to produce such great and tragical effects, by any manifest quality, whether first, second, or third; as physical authors distinguish them.

On this occasion I shall add a very odd accident, about which I was consulted by an expert oculist, very soon after it happen'd. The case was this. A man, as he lay in bed, happening to see a great spider just over his face, caus'd it to be struck at, whilst he continued stedfastly to look at it. Upon which the animal, either frightened, or irritated by the blow, let fall a drop of liquor into one of the man's eyes; who finding no heat, nor sharpness ensue, but rather a very sensible coldness, regarded it not; but presently after happening to rub the other eye, he was surprized to find he had wholly lost the sight of that wherein the spider let something fall.

But to return; the great mischief done to the human body, by very small quantities of poison, seems to argue, that appropriated medicines, especially when administred in a larger quantity, may produce very considerable changes to the advantage thereof. I here expect to be told, that 'tis much easier to do harm than good; and, I confess, 'tis true in general; but in the particular case before us, I consider that some poisons, which produce dreadful symptoms in the body, are frequently cured by their respective antidotes; which, therefore, must have a sanative

MEDICINE. power, great enough, with the help of the ordinary concurrence of nature, to surmount the efficacy of the venomous matter. And, as perfumes often produce various, frightful symptoms, in hysterical women; so the scent of burnt feathers do frequently remove them, in as little time as the sweets produc'd them. And I have often found the smell of strong spirit of hartshorn, or of sal-armoniac, recover such women much more suddenly, than the fragrant odours gave the disorder.

The third and principal inducement I have to allow of specific remedies, is from experience. I might urge, on this occasion, the testimony of *Galen*, who tells us more than once, that he himself, therefore, confided in the ashes of burnt craw-fish, to cure the bite of a mad dog, because never any of those who took it died. And, by the way, he declares, that tho' the effect of these ashes be admirable, even when given alone; yet their virtue may be increas'd, by adding to ten parts of them, five of gentian, and one of frankincense.

I here purposely forbear to mention such medicines, as are by some learned physicians commended for specifics, but question'd or denied by others. It may suffice to take notice of two or three, whose efficacy is more notorious.

'Tis known, by daily experience, that in *Italy*, and other hot countries, tho' the stings of scorpions often produce very acute pains, and formidable symptoms, yet the mischief is easily remedied, either by presently crushing the body of the scorpion upon the hurt, or by anointing the part affected with oil of scorpions; which being made by suffocating those insects in common oil, and keeping it long in the sun, the liquor does not appear to have any manifest quality, to which its sanative efficacy may be ascribed.

The bite of those serpents, which, because of the noise they make with a kind of empty bladders in their tails, we call rattle-snakes, are accounted much more poisonous and dangerous than the sting of scorpions. And yet when the *English* planters in *Virginia*, where they greatly abound, are bitten by these serpents, they very successfully cure themselves by the use of *Virginia* snake-weed.

That the *Peruvian* bark is a specific against agues, particularly quartans, many learned physicians allow; and I remember, the famous Dr. *Willis* said, in a private conference, "'tis the noblest medicine we know." But tho' I will not dispute, whether it be so certain and safe a specific for agues, as 'tis believed by some, yet it can scarce be deny'd to be a specific medicine to stop the fits of agues; for it does that far more effectually, than the generality of physicians, for many ages, could with their other febrifuges.

I my self have seen a stone, of surprizing efficacy in stopping hemorrhagies; and another which performed extraordinary things in more than one distemper; tho' I could not perceive that either of them acted by any manifest quality.

I know,

I know, that those who have rejected specific medicines, confidently MEDICINE. urged three plausible arguments against them. Some physicians deny, that there are any effects of medicines so considerable, as to make them deserve the name of specific. Others would probably allow, that experience favours our opinion, did they not think the manner of a specifics operation inexplicable, and therefore unworthy to be admitted by physicians. And, lastly, others again will allow them to be very efficacious, but endeavour to derive their whole efficacy from manifest qualities, as heat, cold, tenuity of parts, the faculty of making large evacuations, &c.

The reasons urged against Specifics consider'd.

But there is one argument that may be objected against specific remedies, so specious, as to deserve a particular examination; lest it should, if unremoved, beget too strong a prejudice against us. It may be said, that a medicine taken in at the mouth, must in the stomach and intestins, be very much chang'd by digestion, and the aliment it meets with there; and a good part of it, be thrown off with the excrements; that, after it has pass'd the stomach, it must meet with several strainers of different textures, which will, probably, stop most of the medicinal particles that should pervade them; and, that if any shall be so lucky, or so penetrating, as to surmount all these obstacles, they will, probably, either be assimilated into the substance of the body, or be quite alter'd by the parts they must there combine with: or if any so obstinately retain their pristine nature, they will, in all likelihood, be too few to have a considerable operation upon the body. But to this plausible objection, I have several particulars to oppose, by way of answer.

And first, many specific medicines, as ointments, plaisters, poultis's, amulets, pericarpia, &c. being outwardly apply'd; their particles may get into the mass of blood, without passing thro' the stomach; and, consequently, are not concerned in the present objection. (2.) Against most of the *Galenical* physicians, who urge this objection, 'tis arguing *ad hominem*, to remind them, that the same, or as great difficulties, clog a common opinion of their own: for, since they suppose, that purgatives, cordials, diaphoretics, besides cephalics, hepatics, &c. temperate and sweeten the blood, and usefully affect the respective solid parts, to which they are adapted; and since these medicines act not by bare qualities, but by small particles of their own substance; if they can give us an intelligible account of the admission of particles, in considerable numbers, into the recesses of the body, without being deprived of their particular virtues, they will, at the same time, instruct us how to answer the objection they urge against us. (3.) And, as the generality of physicians hold, that milk and urine were materially in the mass of blood, and separated from it by the breasts and kidneys; I think the invalidity of their arguments against specifics, appears from experience. For, 'tis obvious, that rhubarb tinges the urine of those who take any considerable dose of it. And in some of our

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our *American* colonies, there grows a pleasant red fruit, which the planters call the prickled-pear, whose juice is of so penetrating a nature, that it passes from the stomach into the bladder, and thence comes out with so little loss of colour, that strangers, who have eaten thereof, are surprized and frightened at their own urine; supposing it to be blood. As for milk, the great *Hippocrates* himself informs us, that if a woman, or a she-goat, takes *Elaterium*, the cathartic virtue of it passes into that fluid, and purges the child who drinks it. And during my stay in the confines of *Switzerland* and *Savoy*, I observed, that when the cows in that district fed, as they usually do in the middle of summer, upon a certain weed, said to be a kind of wild garlic, the butter made of their milk had a very rank taste of the herb. And I remember too, that passing a winter on the sea-coast of the county of *Cork* in *Ireland*, I found it a known observation there, that a sort of greedy sea-fowl, living almost wholly upon fish, thereby acquired a taste, that makes some pleasantly question, whether the food they afford be flesh or fish. (4.) Lastly, the objection that so small a quantity of a specific, as retains its nature when it arrives at the seat of its operation, must have little virtue left, will not stagger those who know how unsafe it is to measure the power of natural agents, to work upon such an engine as a human body, by their bulk, rather than by their subtilty and activity.

A sober gentleman, who was governour of a colony in the torrid zone, and had sailed far up the river *Gambra* in *Africa*, assured me, that the blacks had a poison, slow and mortal, the dose whereof is so small, that they usually hide enough to kill a man under one of their nails; from whence they very dextrously convey it into any liquid aliment, for the person they design it. He added, that in another part of *Africa*, a famous knight, who commanded the *English* there, and lately died in his passage home, was in this manner poison'd by a young *Negro* woman of quality.

I could name a vegetable substance growing in *England*, which, tho' some empirics employ as a medicine, is so violent in its operation, that a learned and famous modern physician declares, half a grain would cause very dangerous hypercatharises; which have sometimes proved mortal.

And because many ingenious men deny, that our *English* vipers are poisonous; I shall add, in favour of the argument I have been enforcing, that I know a young man, who having been bitten by an *English* viper, which he rashly took hold of, tho' the tooth only prick'd his hand; and the venom, convey'd by so small a hurt, perhaps equal'd not, in quantity, the hundredth part of a pin's head; yet it quickly produced dreadful symptoms in him; and, among others, a violent vomiting. A person, also, whom I knew, that practised physic in the isle of *Java*, where scorpions are held to be more venomous, having been stung in his thumb, by a scorpion, tho' the wound was so small that I could not observe the least scar it had left, it put him presently to most exquisite torture, which

which continued for some hours; during which he felt so raging a heat within, that, to use his own expression, he "thought hell-fire was got into his body:" and thus he continued, till he procured the proper specific. Nor is it only by mere poisons that a human body may be greatly affected, tho' the agent be very inconsiderable as to bulk and weight; for we see, that women, otherwise strong and healthy, will be cast into swooning fits, suffocations, and convulsive motions, by the odours of musk and civet; tho' if all the effluvia that cause these symptoms, were reduced into one aggregate, it would not, probably, amount to a hundredth, nor, perhaps, to a thousandth part of a grain. Thus, also, an inconsiderable quantity of the effluvia of volatile salt and spirit, presently allay these violent symptoms. And as for internal remedies, 'tis vulgarly known, that in the infusion of *Crocus metallorum*, the corpuscles that render the liquor vehemently emetic and purgative, are so very minute and subtle, that great proportions of wine, or other vehicles, may be strongly impregnated thereby, without any sensible diminution of the body that affords them. And of this we have, perhaps, a more considerable instance, when quick-silver is boiled, or long infused in common water. For, *Helmont* observes, that tho' the liquor be not alter'd in colour or taste, nor the quick-silver at all sensibly changed, nor grown any thing lighter on the balance; yet the liquor, by means of these insensible and unponderable effluvia of the quick-silver, acquires a notable virtue against worms; for which purpose, not only *Helmont*, but others, extol it. And I remember, that a fine boy, born to be heir to a very illustrious family, falling into a dangerous fever, which was judged to proceed from worms, or verminous matter; the famous and experienced physician, who treated him, confess'd he had no hopes of him; because the child, bred to have his will, and being tired with unsuccessful remedies, was so obstinate, as to drink nothing but small beer. Whereupon I advis'd his beer to be impregnated with mercurial particles, by frequently shaking pure quick-silver therein. By which means, the patient perceiving no change of colour, nor taste in the drink, swallowed it greedily, and soon after recover'd.

I should condemn my self for having bestowed so many words upon one objection, but that I hope the answer given to it in this place, will facilitate and shorten our future task.

Having then dispatched the first of our two enquiries, I proceed to consider, whether the mechanical hypothesis can be accommodated to the notion of specific medicines, so as to explain their operation, either intelligibly, or prove it agreeable thereto.

And here I must freely confess, however superficial our knowledge may be, and however abstruse and veil'd the operation of specifics; yet, considering the large extent, and great fertility of the mechanical philosophy, I cannot despair that several effects of such medicines, may, in a general method, be explain'd by it.

Whether the notion of specifics may be accommodated to the mechanical philosophy.

But

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But before I come upon this explanation, let it be observed, once for all, that I content my self, on most occasions, to give only possible explications; and to shew, that specific medicines may operate in the manner I propose; without affirming that to be the very manner in particular cases; because we need not grant, that the operations of all specifics, or of the same, in different diseases, must be of one kind: for, different specifics may operate in several manners; and some by one means may cure one disease, and others another. Nor need the specific remedy always relieve the patient, by this or that single manner of operating, but by a concurrence of two or more, that, as it were, join their forces to produce the desired effect.

For a foundation to the following propositions, it must be remember'd, that an animated human body is not a mere statue, or congeries, of the materials 'tis compos'd of; but an admirably fram'd engine, consisting of solid, liquid, and pneumatic substances, so exquisitely adapted to their respective functions and uses, that the effects of an agent upon it, are not commonly to be measured by the power of that agent, consider'd in it self, but by the effects consequently produced from the action of the parts of the living machine upon one another.

P R O P. I.

A specific medicine may cure, by discussing or resolving the morbid matter, and thereby fitting it for expulsion thro' the greater outlets of the body, and the cuticular pores.

'Tis known, that many obstinate chronical diseases often proceed from viscid humours, that obstruct the canals wherein the blood should circulate, or other useful fluids be transmitted. And these peccant humours are often so tenacious and obstinate, that ordinary remedies will have little effect upon them. But a specific may, by the smallness and suitable figure of its corpuscles, get thro' the pores into the recesses of this stubborn matter; and thus, by their solidity, figure, and agitation, promoted by the heat of the patient's body, dissolve and ruin the texture of the morbid matter, and render it capable of being naturally proscribed by urine, sweat, or some other commodious and innocent evacuation. Thus, the blood, or other fluid of the body, being impregnated with the benign and operative particles of the remedy, becomes an appropriated menstruum to the peccant matter. Thus sal-armoniac may be diluted into a menstruum, that, by degrees, will dissolve both copper and iron. The menstruum, in this case, must be appropriated, because there is no sufficient reason to suppose, that it works by any manifest quality, as heat, moisture, &c. or even by acidity: but rather, by virtue of the fitness, which the shape, bulk, solidity, and other mechanical properties of its particles, concur to give it, to shake asunder the parts of a body of such a determinate texture. For there are many more distinct

distinct sorts of menstua than are commonly taken notice of; and the MEDICINE. operations of these cannot safely be measured by the strength of their manifest qualities; since it may often happen, that a menstruum, less acid, or less strongly tasted, may dissolve this or that body, which another menstruum, that seems far stronger, will not work on. Thus cold water will dissolve the white of an egg, which pure spirit of wine, oil of vitriol, or spirit of salt, will coagulate. Thus rectified spirit of urine, will readily dissolve minute filings of copper, which spirit of vinegar will but slowly corrode; and yet this liquor will speedily dissolve crabs eyes, which spirit of urine will leave entire. Thus quick-silver, that is insipid, will, without heat, dissolve gold, which *Aqua fortis* it self, tho' assisted by fire, will not touch; and yet *Aqua fortis* will furiously tear asunder the parts of iron, tho' quick-silver will not so much as adhere to its surface. And thus, in short, common oil, that is so smooth upon the tongue, and will not corrode so much as an egg-shell, will dissolve brimstone, which resists *Aqua fortis* it self, that dissolves almost all metals, besides many hard stones and minerals. And I have prepared a liquor, which, tho' so weak that one may safely drink a wine-glass full of it, pure, will yet operate on some very hard bodies, both stones and metals, in a way that is not to be match'd among the highly corrosive menstua used by chymists.

And now, supposing that the active corpuscles of a specific medicine, associated with the blood, or other vehicle, may act upon the morbid matter they meet with, in the manner of a menstruum, we may illustrate several particulars with regard thereto.

And, first, we may hence conjecture, why an appropriated medicine will perform, what another cannot; tho' its manifest qualities seem to be of the same kind, and much stronger in degree. For, menstua do not always act according to the degree of their acidity, or the like sensible quality, but according to the congruity of their parts, to the pores of the body they are to dissolve; and frequently, also, according to a fitness that depends upon other mechanical properties of the acting liquor. And, therefore, physicians, as well as others, may easily mistake, in arguing *à majori ad minus*, and *à minori ad majus*. For, because water will dissolve gum arabic, therefore that highly rectified spirit of wine, which is a much more subtle and penetrating liquor, must dissolve gum arabic, is a false conclusion: or thus, because strong oil of vitriol is more corrosive to the taste, and will dissolve many bodies that *Aqua fortis* will not, therefore that it will dissolve silver as well as *Aqua fortis*, is false, and the contrary true. Nay, this is not a just inference; *Aqua fortis* dissolves silver by virtue of its acid spirits; therefore the more it abounds with these, the more powerfully will it dissolve that metal: for, if *Aqua fortis* be made exceeding strong, it will not work upon silver, but readily, after it has been weakened by the addition of a fit quantity of common water.

MEDICINE. To all this I might add, that the dissolution of a body may depend, as well upon the peculiar texture of the body it self, as the manifest strength of the menstruum.

2. This doctrine may suggest the reason, why a medicine, that has a great effect in one disease, proves ineffectual in another, apparently of kin to it, and perhaps less obstinate. For, the presumed analogy between them may not be so great, but that some dissimilitude of texture in the morbidic matters, may render the one unfit to be wrought upon, by the same menstruum that dissolves the other. Thus, tho' pure spirit of wine will easily dissolve gum guaiacum, and the little portions of resinous matter that are harboured in the pores of the wood; yet the same menstruum will not work upon the wood of the tree that affords these soluble substances.

3. This may keep it from appearing strange, that specific medicines should sometimes fail of their desired effects. For, as the bodies of individual patients may greatly differ, either in their natural constitution, that they acquire by the disease, or in both; so 'tis not surprizing, that in some sick persons, among many, the congruity between the agent and patient should be alter'd, either by a considerable change in the texture of the morbidic matter, or some alteration that the corpuscles of the medicine receive in their passage thro' the vessels, by the admixture of some incongruous particles of the blood, or other vehicle. Thus both spirit of salt, and that of nitre, will dissolve copper, and the latter silver; yet if you mix the other with spirit of salt, which, by its like operation upon copper, seems of the same nature, the spirit of nitre will be no longer able to dissolve silver, as it would before.

4. Our hypothesis may, also, hint an answer, to one of the chief and most plausible objections produced against specific medicines. 'Tis ask'd, how a medicine can possibly rove up and down in the mass of blood, and, neglecting whatever else it meets with, single out and fasten upon the morbidic matter to be proscribed. Why, if the medicine acts by impregnating the blood, or some other fluid of the body, and turning it into a kind of menstruum, 'tis very possible that the strainers, thro' which the corpuscles must pass, may keep back the inconvenient parts of the vehicle; and, which is in our case more considerable, that the menstruum may be either appropriated to the peccant humour; or else, at least, be qualified to resolve that more easily, than any other substance it meets with in the body. Thus if bone-ashes, *Crocus martis*, saw-dust, powder'd sea-salt, and filings of gold, be blended all together, and afterwards divided into two parcels, and upon one you pour common water, it will readily dissolve the salt, and leave the other ingredients untouch'd; and if upon the other part of the same mixture, you put a sufficient quantity of quick-silver, and rub them together, this metalline liquor will only fasten upon the gold. And those who work in the *Spanish* gold-mines inform us, that when they have well ground
some.

Some ore that contains gold and copper, besides heterogeneous minerals, well heated quick-silver will take up the gold, much sooner and better than it will the copper; which it scarce meddles with, as long as there remains any considerable quantity of gold to be wrought upon. As for the supposed difficulty, that the medicine should search out the morbid matter, in what part soever of the body it lies; this objection might have been considerable, before the discovery of the blood's circulation: but now we know, that whatever gets into the mass of blood, is presently whirl'd about with it; and may, therefore, be convey'd even to the remotest vessels.

5. Our hypothesis, also, may help us to answer those many learned physicians, who either reject or despise most external remedies, especially pericarpia, amulets, and appensa, upon a supposition, that they can neither communicate to the body any store of medicinal particles, nor reach internal diseases; especially when seated in parts remote from those whereto the medicine is applied.

But we need here only consider, what abundance of particles, sensible to the nostrils, are, for a long time, emitted by a small quantity of amber-grease, or of camphire; and the multitude of magnetical corpuscles, that, for many years, constantly flow from a small vigorous load-stone; to make it appear possible, that even dry and solid bodies may afford sufficient store of effluvia, to produce considerable effects in so curious an engine as the human body. And as to the second part of the objection; the most eminent modern physicians allow the porosity of the skin, whereat 'tis very possible for the subtil effluvia of several bodies to enter; and when these have once got admittance into the smaller vessels, 'tis easy to conceive, how they will thence be carried into the greater; and, consequently, into the mass of blood; by whose circulation they may be readily transmitted to all the parts of the body, and so to the seat of the disease. And, perhaps, the efficacy of these corpuscles may be the more considerable, because they get presently into the mass of blood, without undergoing those digestions in the stomach, and other parts, which oftentimes greatly weaken the virtue of medicines, taken in at the mouth, before they arrive at the blood.

P R O P. II.

A specific may subdue the too great proportion of acid, or other luxuriant particles, in the mass of blood, and prevent their coagulatory, or other pernicious effects.

Tho' I cannot impute almost all diseases to acidity in the blood, and other fluids of the body, by means whereof the solids are also offended; yet, I readily grant, that a considerable number of distempers may chiefly proceed either from acids themselves, or their bad effects. And, accordingly, we may very probably conceive, that several disorders may

MEDICINE. be either quite cured, or greatly lessen'd, by a specific, that abounds in corpuscles fitted to obtund acids. Now, such an effect is producible by more ways than one, but the principal that now occur to my thoughts are these two.

First, there are some bodies that mortify, or disable acids, by a positive hostility, or such a contrariety, as is discernable by the taste, the visible conflict, and manifest tumult produced when they invade each other. Such bodies are those called alcalizate salts; whether fixed, as the lixivate salts of plants, or volatile, as the spirits, and ascending salts of urine, blood, hartshorn, &c. as may be exemplify'd by mixing any of these with *Aqua fortis*, spirit of salt, oil of vitriol, or the like acid liquors. Whence, by the way, we may see, that those *Galenists* mistake, who ascribe the virtues of spirit of hartshorn, and of urine, only to their tenuity of parts, briskness of motion, and the like properties; that they might not seem obliged to the chymists for so useful a notion, as that of the contrariety of acids and alkalies.

The other principal means by which acids may be mortified, is, by being sheath'd; for an acid corpuscle may lose its power of cutting or pricking, either by having its figure spoiled by the action of a strong and manifest alkali; or else by being cover'd in a porous body, that, perhaps, is endowed with no taste, or any other manifest quality. Of this way of mortifying acids, chymical operations afford us many instances; as when minium destroys the acidity of spirit of vinegar, chalk that of *Aqua fortis*, and *Lapis Calaminaris* that of spirit of salt, and even of spirit of nitre. And I the rather mention *Lapis Calaminaris*, because its qualities are less known to physicians, and the generality of chymists; and because it supplies me with an argument, to prove that acids may be rather sheathed than destroyed, by the bodies that silently mortify them. For, as *Glauber* justly observes, acid spirits may, by the force of fire in distillation, be driven out of that stone very much dephlegmed, and stronger than before.

I know it may be here objected, that the mortification of acids is performed by a manifest quality; and therefore proves nothing in favour of specific medicines. But to this I answer, first, that the power of mortifying acids, by sheathing them, or by absorption, is none of those qualities, whether first, second, or third, that the *Galenists* allow in medicines; tho' their sufficiency to cure diseases, has been, and still is urged by many, against the specific virtues of remedies. Secondly, that it is an unhappy and dangerous mistake, that so many learned modern physicians should take it for granted, that if a medicine be endowed with a manifest quality, its good or ill effect may be ascribed to that quality, whether it be acid or alkaline; for there is a considerable difference, as various trials have assured me, between one acid and another, and between one alkali and another: 'tis fit, therefore, to distinguish betwixt an acid, as merely such, and the peculiar modification that may belong to that acid. Thus, tho' all acid menstrua, that I know of, will, if they

they be well dephlegmed, dissolve copper; yet *Aqua Regis*, that dissolves not only copper, but gold, will not touch silver; as, on the other side, *Aqua fortis* will not, of it self, dissolve gold; but if you give it a new modification, by adding to it common spirit of salt, which, as I have often found, leaves that metal entire, the *Aqua fortis* will easily dissolve it. Nay, a different modification may not only cause a difference between acids, but what would commonly be called a contrariety; for spirit of salt will precipitate silver, which *Aqua fortis* has dissolv'd; and spirit of nitre not only precipitates an antimonial powder out of that odd substance, butter of antimony, but does it with a surprizing conflict, tumult, and effervescence; yet this butter of antimony is so highly acid, that a little quantity of it turns a considerable one of water so sour, that many chymists call such a mixture *Acetum Philosophorum*.

To apply all this to the propos'd objection; I at first plainly intimated, that a specific medicine might sometimes operate, in part, by a manifest quality, tho' the good effect it produced, were not due, barely to the kind or degree of that manifest quality, but to somewhat superadded, upon which its specific virtue, in a particular disease, depends. And, accordingly, it may be said, that as there are several kinds of acids and alkalies, too, 'tis not every acid that will be mortified by every alkali, and thereby have its effects destroyed; which may be illustrated from hence, that tho' when copper is dissolved in *Aqua fortis*, 'tis possible, by the help of mere chalk, skilfully applied, to make the menstruum let go the corpuscles of the metal; yet if, upon such a high colour'd solution of copper, you shall pour a due quantity of spirit of urine, or the like volatile alkali, tho' there will presently ensue a great conflict, and manifest ebullition, with noise and numberless bubbles, yet between these hostile salts, a multitude of the acid corpuscles of the *Aqua fortis* will not be so mortified, as to let go the metal; but the solution, varying its colour, will acquire a deeper than before.

And when I consider the differences to be found between vinegar, alum, crystals of tartar, juice of lemons, juice of barberries, the essential salts of sour plants, &c. I am apt to think, that nature, in disorder, may produce, in a diseased body, acids of several sorts, which are not particularly known to us; and that some of these may have such a peculiar disposition, that our common alkalies will prove unable to dissolve them; which yet may be conquer'd by sheathing them with some appropriated, or peculiarly modified corpuscles of a specific remedy. This may be illustrated from hence, that tho' neither spirit of vinegar, spirit of salt, nor oil of vitriol, would, as far as I have try'd, dissolve a stone taken out of a man's body; yet spirit of nitre, which leaves untouch'd some bodies that oil of vitriol will dissolve, would readily work upon it, and thereby lose its corrosiveness.

There

MEDICINE.

There are two things that I would have remarked, before I leave this subject. One of them is, that preternatural acids not only dis-affect the body, whilst they continue sensibly acid; but, in many cases create distempers, whereof most men would think them the remedies. For, tho' acids be reputed to have an incisive and resolute virtue, and are, therefore, prescribed to cut tough phlegm, and to dissolve coagulated blood; yet, as I readily grant this virtue to acids in some cases, so there are others, wherein I greatly suspect, that obstructions, and their consequent diseases, may be occasioned by the same; as they coagulate some fluids in the body, which are thereby rendred unfit to pass with the rest of the blood, thro' the smaller vessels and strainers of it. This I shall exemplify by the coagulation produced, by adding spirit of salt to the white of an egg, reduced to an aqueous consistence; and the like may be easily effected in milk, which not only speedily curdles with spirit of salt, but, as is vulgarly known, with runnet, juice of lemons, &c. And experiments, purposely made, have shewn, that if some acids be conveyed immediately into the mass of blood, they will coagulate that fluid it self, whilst it continues in the vessels of living animals.

The other particular I desire should be here observed, is, that tho' acid corpuscles are, by some modern physicians and chymists, suppos'd hurtful, both in the blood, and several solid parts of the body; and tho' some ingenious men impute almost all diseases to the bad effects of acids; yet I am very inclinable to think, that many diseases and ill symptoms proceed from corpuscles, that, whether of a saline nature, or not, differ from acids properly so called. For bodies may, as 'twere, result from the combination of acids with other saline particles, that much alter their nature. Thus, spirit of salt will, with spirit of urine, compose a kind of sal-armoniac; and spirit of nitre, with salt of tartar dissolv'd in common water, will con-coagulate into salt-petre, or a body exceedingly like it; and the same spirit of nitre, or *Aqua fortis*, with spirit of urine, or of blood, or the like, will afford a very fusible salt, very different from either of the ingredients, before their conjunction. And 'tis vulgarly known, that oil of vitriol, and oil of tartar *per deliquium*, produce, by their coalition, *Tartarum vitriolatum*; in which, both the acid and the alkali are very much infringed; the third body produced greatly differing from either of the liquors. And considering how many different sorts of corpuscles nature may have form'd, that, without being acid, may yet have notable and pernicious effects upon the blood, or some particular solid of the body; it seems probable, that other qualities are required, to mortify or disable these morbid corpuscles, than a contrariety to acid salts; and, consequently, that a medicine, whose parts are peculiarly fitted to correct, or enervate a particular sort that is noxious, may deserve the name of a specific.

But

But further, as various coagulations may be made in the body by MEDICINE. saline corpuscles, manifestly acid, so others are producible by corpuscles, whether saline in taste or no, that are not manifestly acid, but, perhaps, of a contrary nature; which observation, tho' usually overlook'd by physicians, is, in my opinion, of no small importance, and therefore may deserve to be more fully made out. I have, sometimes, prepar'd a liquor, that was not, in taste, either acid or urinous; whereto having put a moderate proportion of distill'd liquor, which also was, in taste, neither acid, urinous, or lixivious, it would, in a few minutes time, be coagulated into so firm a body, that, tho' the open wide-mouth'd vessel, that contain'd it, was held with its orifice downwards, nothing would fall out thereat.

And if, upon a certain solution, some spirit of urine, or another volatile alkali, be let fall, there will presently be produc'd a gelly, whose consistence, and colour, may make it easily mistaken for common boil'd starch.

The like gelly, but more transparent, I have also made without the help of any thing sensibly acid, or urinous. And, to satisfy some virtuosi, I have shew'd them, to their surprize, a substance which I could presently prepare, without urine, or any volatile alkali, that would immediately coagulate about twice its weight of highly rectified, and inflammable spirit of wine, into a solid mass.

And, to manifest that 'tis not requisite that a liquor be sensibly acid, to coagulate an animal substance, as I lately observ'd the spirit of salt did the white of an egg, highly rectified spirit of wine will do the same thing as well, if not better.

P R O P. III.

A specific may prove serviceable, by precipitating the peccant matter out of the blood, or other fluid of the body.

Tho' precipitation be frequently a consequence of the mortification of acids, or of alkalies, by corpuscles of a contrary quality, yet I thought fit to say something of it a-part; because I have observ'd, that some acids and alkalies may be put together, without causing any precipitation by their contrariety: and, on the other side, that various precipitations may be produced, where there does not appear any hostility; though, I know, this effect is often thought a sufficient argument of a preceding conflict of acids and alkalies; but that should be prov'd by collateral experiments.

To proceed to our own examples. I know several urinous spirits, that will mix with acid menstrua, without any manifest conflict or precipitation; and, on the other hand, some acids and alkalies, that will make a manifest conflict by their mutual re-action, yet, if mingled in a just proportion, there will be a manifest coalition, instead of a precipitation;

MEDICINE. tation; as may be exemplified in certain quantities of spirit of sal-armoniac, made with salt of tartar, or pot-ashes, and spirit of nitre, or *Aqua fortis*; and also by spirit of urine, and spirit of salt, mix'd in a certain proportion; whereby they convene into corpuscles, for the making of sal-armoniac, which the phlegm of those liquors will keep swimming. But, what makes most for my present purpose, there may be precipitations, where no tumult, or contrariety, appears; as when silver, being dissolv'd in *Aqua fortis*, and the menstruum diluted with 30 or 40 parts of distill'd water, if clean plates of copper be immers'd in the solution, the silver will be very slowly precipitated out of it, in the form, not of a calx, consisting of metalline and saline parts incorporated together, but in the form of pure shining scales of silver, almost like the white and glittering scales of some small fish. There is, also, a way, by which I have brought dissolv'd gold to settle about a body suspended in its solution, in the form of a fine, and a high-colour'd calx of pure gold. But you may have an instance of silent precipitation, by rubbing a little, either of *Roman* or *Dantzic* vitriol, upon a newly whetted blade of a knife, moisten'd with water; for the steel will thus immediately be overlaid with a reddish substance, which, by its colour, and other signs, appears to be manifestly cupreous. And 'tis not only out of solutions, made with acids, that bodies may be thus precipitated; for, upon search, I have found, that there are, in nature, precipitants capable of silently precipitating some bodies, dissolv'd in urinous, or other, not acid, menstrua. It may, indeed, be justly suspected, that such precipitations are dangerous, by producing heterogeneous corpuscles in the blood, that may prove too heavy, or gross, to be evacuated. And I look upon this as a suspicion to satisfy which 'twere fit to consult experience; but, in the mean time, it may be represented,

1. That tho' some inconveniencies may happen from the bulk of the precipitated corpuscles, yet this may be much inferior to the danger threatned by the over-active, and hostile particles, that produced, or fomented the disease.

2. That 'tis not necessary all concretions should consist of corpuscles, too large to be thrown out at the mass of blood; for, we see, that stony matter, which, as the chymical analysis of it shews, is of a very compound nature, may be carry'd to all parts of the body. I knew a lady, who had a stone taken out of the lower part of her tongue. And physicians, who prescribe large quantities of mineral waters, impregnated with iron, as I found those of *Tunbridge* to be, and with sulphur, such as some of the *Barb* waters usually are, build their expectations of a cure from them, upon a supposition that they are carried into the mass of blood, and innermost parts of the body.

3. That yet precipitations may, possibly, be made of matter, contain'd in the blood, by medicines that do not get into the mass of it. Physicians, sometimes, give crude steel in substance, as well as prepared, to obtund the acidities of the blood, tho' the metalline corpuscles, in
all

all probability, do not pass into the mass of that fluid, but are wrought upon by the matter, that, in its circulation, is thrown into the stomach and guts; which appear to be the seat of the operation of chalybeates, from the blackness they give to the excrements of the lower belly: but if they will have it, that prepared steel, for instance, calcin'd with sulphur, passes thro' the pores of the intestines, or the fine lacteal vessels, into the mass of blood; 'twill be obvious to demand, why nature should not be able to expel precipitated corpuscles, at the same orifices, where such compounded concretions as those of sulphur and that metal can enter.

4. That it may, with some appearance of reason, be said, experience has already been consulted about the expediency of employing precipitating medicines. For, not to urge that the learned *Sennertus* seems to intimate, that sometimes the febrile matter may be precipitated out of the blood; *Kergerus* very solemnly declares, that, in the space of fourteen years, he cured above a thousand of fevers, without bleeding, purging, sweating, &c. by a single precipitating remedy, and that universally, with all imaginable ease and safety. I endeavour'd, indeed, to obtain from *Germany* a confirmation of this matter of fact, but did not receive it; I find, however, that one of the emperor's physicians, declares himself inclin'd to believe it true.

But I can more easily suppose, that great, and desirous changes may be wrought in the fluid parts of the body by appropriated precipitants, if it be true, as it is unanimously taught by a multitude of physicians, that many diseases are caused by a putrefaction of the blood, and other animal fluids. For there is, in nature, a certain substance, or medicinal liquor, so powerful an enemy to putrefaction, that when a few grains, or drops of it, were put into a considerable quantity of water, that had been kept till it stunk as strong, and offensively, as carrion, (tho' it still remain'd transparent) and diffused, by agitation, through it, precipitated therein a very small and light feculency, which being remov'd, the remaining liquor was quite freed from all ill scent; nor did I observe, that the feculency it self retain'd any. And, which is surprizing, all this was done in a very few minutes, by a very small proportion of a precipitant, whose taste was not at all either bitter, or acid, or urinous, or lixivious; which are circumstances that may afford considerable hints to sagacious inquirers.

PRO P. IV.

The specific may peculiarly strengthen and cherish the heart; and, by that means, or otherwise, relieve the part affected.

This observation can scarce be made good, without entering into that important and perplexed controversy, whether any medicines have a sympathy with the head, heart, liver, &c. and, upon that account,

MEDICINE. deserve the name of cephalic cordial, hepatic, &c. or to speak more clearly, whether there be any medicines, that, in a peculiar manner, do good to this or that particular internal part of the body. In this dispute the affirmative has been held, tho' I doubt upon slender grounds, in most of the physical schools, for several ages. But, in our times, many maintain the negative, and even deride the opinion they have forsaken. Some of them object, in a triumphant stile, that 'tis ridiculous to fancy such a sympathy betwixt a dead medicine and the parts of a living body; as if a physician could send a drug of an errand, to single out a particular part among a multitude of others, and do it good offices.

But, notwithstanding this, I think it very possible, that a medicine may so far respect a particular part, as tho' not to prove beneficial to that only, yet to be serviceable to it in a peculiar manner or degree: and this, I conceive, may happen upon one, or more, of the following accounts.

And, 1. when I consider, that the firm parts of the body, as the heart, brain, liver, kidneys, &c. have each its particular structure, wherein it differs from another; and probably the fluids also, as the blood, gall, lymph, &c. have their several textures; it seems probable to me, that the corpuscles of a medicine, dissolv'd in the stomach, and carry'd round by the liquors of the body, may, according to their determinate shape, size, stiffness, flexibility, motion, &c. be much more fit to lodge in one part of the body than the rest, and, thereby associating with its fibres, supply it with such congruous particles as it either wants, or may prove beneficial to it, by re-establishing or strengthening its tone. And by this corroboration, the part may be enabled to resist the hostilities of morbid matter, which physicians frequently observe to be thrown by the more vigorous parts upon such as are weak or distempered; as is manifest in persons subject to the gout, in whom peccant humours are very apt, upon several occasions, to be translated from the nobler parts; if those be robust, upon the debilitated joints: on which score, the gout, if it be well managed, is not, without reason, thought conducive to long life. Thus I knew a physician, who had such a peculiar indisposition in his jaw, that tho' he could use wines of several sorts, without inconvenience, yet the drinking of a very little brandy, would soon give him the tooth-ach.

But I proceed to shew and illustrate, how the fitness of some medicinal corpuscles, may enable them to associate with those of the part they are to affect. We see, from what happens in nutrition, especially in that of sucking children, that a single aliment, as milk, affords, besides various excrements, such as the grosser feces of the guts, and the more fluid ones of the bladder, the nose, the cuticular pores, &c. a great number of corpuscles that are detained and assimilated by parts of different structures, as the brain, the heart, the bones, &c. since, otherwise, these parts

parts could never be so plentifully nourished by them, as daily to increase in all their dimensions. And some parts, which in infants are cartilaginous, in process of time become bony; a change not probably referable to the bare exiccation, by the native heat of the body, increasing with age.

2. The friendly corpuscles of a specific medicine, may not only confirm the good state of a determinate part, but greatly conduce to restore it to a sound condition, when it is distemper'd; and this by two or three different means.

And, first, those particles may dispose the morbid matter to be more easily and safely expell'd; and that not barely as they may impregnate the whole mass of blood, and so be carried by it, as well to many other parts, as to that we now consider; but as their particular texture, motion, &c. may, in a peculiar manner, respect that particular modification, which the peccant matter acquires, by being produced or harboured in that determinate part. And that the particular structure of an affected part, may very much diversify the condition of a morbid matter, I argue from hence, that physicians declare, the petrifying matter bred in the kidneys of a person subject to the stone, to be reddish or yellowish; but when in the bladder, white, or of a light grey; and the stones generated in the former part, to be more friable, or of a slighter texture than those that have their origin in the bladder; some of which are exceeding hard, especially in comparison of such large ones as I have had out of the bladder, or gall, of lusty animals. The disposition then, that the corpuscles of the specific may give the blood, or other liquor which conveys them, to act as an appropriated menstruum, upon the peculiarly modify'd matter that obstructs or disaffects the liver, for instance, may enable the remedy to be very helpful to that part, by preparing the morbid matter for expulsion. But it may also assist the same part in another capacity.

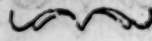
For, secondly, it may so work upon the fibres, and stable portion of the part affected, as both to enable and excite it to get rid of its enemy; as by giving firmness and strength to the fibres of the part, by contempering, or correcting the immoderate heat, coldness, &c. thereof; by mortifying the acid, or other heterogeneous particles, that are lodged in the minute intervals of it, and, perhaps, even in the pores of its fibres; by allaying its convulsions, cramps, or other inordinate motions, that hinder it from performing its proper functions; and, lastly, by relaxing or widening the pores, according to the exigency of the work to be performed. And, having thus prepared the matter to be expell'd, and disposed the part to expel it, this may then also be excited to its office, by the same particles irritating the fibres, or motive organs, or stimulating them, to disburden the matter that offends it. Thus a very small dose of cantharides, is known capable of making the bladder forcibly discharge it self of urine; and often at the same time to

MEDICINE. expel the sand, gravel, small stones, and other excrementitious matter, that before molested it.

And hence we may answer an objection, formerly mentioned against specific medicines. For here we have a medicine, tho' a dangerous one, whose corpuscles are so peculiarly adapted to the bladder, and urinary organs, that tho' when got into the mass of blood, they are carried by it indiscriminately to all parts of the body; yet often, without manifestly disordering the rest, they exceedingly affect and irritate the bladder alone. It may here be objected, that the first of our three ways, in which we say a particular part may be assisted by a specific, seems contrary to the second; the former tending to corroborate, and the latter to relax and irritate it. But I answer, that since the part may be sometimes in a natural, and sometimes in a preter-natural state; in the former a medicine will deserve to be call'd appropriate, from keeping it sound, which is most properly done by strengthening it; and in the latter, merit the title of a specific, because it helps to restore it to a state of soundness. And, again; tho' to effect this recovery, 'tis often very expedient, that the medicine procure an evacuation of some peccant matter, yet that evacuation is frequently much promoted and facilitated, by strengthening the part, so as to enable it to disburden it self. And the same medicine may contain and communicate to the blood, corpuscles of such different shapes, sizes, motions, &c. as successively to relieve the part by both these means. Thus, physicians observe, that rhubarb not only purges the liver of choler, by its fine, laxative parts, but by its more earthy, astringent corpuscles, strengthens the tone of that part. I might add, that, in some cases, this very corroboration of a distemper'd part may restore it to soundness; there being some diseases of such a nature, that they could not subsist in the affected part, unless thro' its debility, and the consequences thereof, it were subject to admit, from time to time, fresh recruits of peccant matter to foment the disorder. And, in such distempers, if the structure and tone of the part be re-established by the operation of the specific, its acquired vigour will enable it to resist the entrance of new supplies of peccant matter, and to return them into the mass of blood, to be thence discharged by the common shores of the body. In the meantime, nature will be able, by degrees, to subdue, dissipate, or otherwise dispose of that little portion of morbid matter that was lodg'd in the diseased part.

We have not hitherto produced any example of the peculiar respect of a specific, to a determinate, disaffected part, apparently so incredible, as that a heavy, stony substance, being, in small quantity, taken at the mouth, should manifestly contribute to the cure of a broken bone, in the extreme parts of the body; yet, not to urge the testimony of chymical writers, I remember a *German* physician, who was famous for great cures, related wonders of that stone called *Osteocola*, especially if improved by a skilful preparation, which he communicated to me.

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But without preparation, the judicious *Hildanus* greatly commends it, MEDICINE. upon his own observation, for very suddenly breeding a callus in fractures. 

P R O P. V.

A specific may have its effect, by producing in the mass of blood a disposition to enable nature, by correcting, expelling, &c. to surmount the cause of the disease.

Whoever narrowly considers the practice of the most successful modern physicians, will find that their prescriptions are, in general, founded upon a supposition, that a great part of diseases depend chiefly upon the vitiated constitution of the blood, and their cure upon restoring that fluid to a sound state.

Now this advantageous change of the blood may be effected by a specific, several ways; and, particularly, first, by furnishing the blood with some sort of active corpuscles, necessary to ferment it, or excite an useful commotion, or agitation therein. I do not here design to examine, whether the mass of blood, contained within the vessels of a living man, is capable of a strict and proper fermentation; and therefore I have employed the word commotion, for such as dislike the other.

But as fermentation is become a general term, I shall not scruple to use it, after having premised, that because many modern physicians, especially since the learned Dr. *Willis's* notions came to be in request, have supposed fevers and agues to consist in vitious fermentations of the blood; to distinguish the fermentation I here mean, from theirs, I call it useful.

Since, probably, then, there is often a vitious fermentation of the blood, there may also sometimes be a want of fermentation, or a certain sluggishness; upon whose account, either the brisk, intestine agitation, that fluid ought to have in healthful persons, or a due quickness of circulation is wanting; upon which sluggish state of the blood, if it prove obstinate and lasting, several distempers are usually consequent. There are, indeed, various medicines, such as aromatics and spirituous liquors, distilled from fermented vegetables, sometimes successfully employed to correct this dull disposition of the blood; but as these prove very hot, there will be several constitutions, and particular circumstances wherein they may do more harm by their immoderate heat, than good by their spirituousity. Besides, the sluggishness of the blood may sometimes proceed from causes, that this sort of hot medicines will not correct. I remember, that having moderately dry'd and powder'd a parcel of human blood, a vinous spirit totally inflammable, would not in many hours make a solution of it, or draw a red tincture from it; but a well rectified urinous spirit grew red upon it, in less than the tenth, or perhaps the twentieth part of that time.

A

MEDICINE.

A specific medicine may, therefore, abound in corpuscles of such a nature, as, without dangerously heating the blood, to dissolve those particles that render it viscid, ropy, or spiritless; and also, by enlivening the whole mass, and putting it into a more brisk and kindly agitation, thereby fit it to throw off such heterogeneous parts, or recrements, as were blended with it before; whence 'twill again freely pass along the finer vessels of the body.

That a specific may perform this, will be more easily allowed, after considering that the generality of physicians acknowledge, there are several cordials, some of which they stile temperate, and others cold: and 'tis very possible, that the corpuscles, which render the blood thick and sluggish, may not be of a cold nature, but of a hot; and therefore may have their effects rather promoted than destroyed by hot remedies. Thus, as we formerly said, if to the white of an egg you put a certain proportion of well rectified spirit of wine; instead of destroying the viscosity of the liquor, it will curdle a good part of it, and thereby produce a body far more remote from thinness and fluidity than it was before. And I remember I once made a sluggish vegetable liquor, which presently, by the addition of a little spirit of wine, became surprizingly viscous and ropy.

2. Another means, whereby a specific may befriend the mass of blood is, by giving it the wanted dilatation or tenuity. This second way, indeed, is of kin to the first, but different from it; because in that the thing principally considered was, the fermentation or agitation of the blood; but this chiefly respects the consistence of it; a particular of great importance to health: for if the blood be too thick, as often happens, it cannot pass so freely and readily as it ought, thro' the capillary vessels; which thence become gradually obstructed, and the circulation retarded. And, on the other side, if the blood be too thin, and especially if too vehemently agitated, 'tis apt to make its way out of the vessels, and produce hemorrhages, or other bad effects, that usually attend the extravasation of the blood; which happening in so warm a place as a living human body, that fluid is very apt to putrefy, and thereby produce impostumes, and several dangerous symptoms.

Now a specific medicine may remedy this faulty consistence of the blood, by furnishing it with corpuscles, fitted by their figure, bulk, motion, &c. to disperse those that make the blood gross; or else to cut or divide the parts of the blood it self, and so dispose them to a greater fluidity. It may also produce in it such pores, as will give admission to the subtil etherial matter, that abounds in the atmosphere, whereby the blood may be rarified. And, on the other hand, when the blood is too thin, as not only some diseases, but some medicines too, especially aloes, often make it; a specific may reduce it to a good consistence, either by furnishing it with corpuscles, apt to combine with the active ones, that did too much attenuate it before; or by helping nature

nature to expel those busy particles by insensible transpiration, or some other easy way. MEDICINE.

3. There is yet another manner wherein a specific may conduce to rectify the state of the blood; and that is by so working on the heart, as to make it advantageously regulate the transmission of that fluid thro' it.

That a specific may peculiarly befriend a particular part, and consequently the heart, is granted by the generality of physicians, who think themselves possessed of many cordials, as they call them; and we have already shewn it possible: 'tis, therefore, allowable to suppose, that the parts of a specific may either dissolve some particles they meet with in the heart, by which that noble viscus is, by irritation, or otherwise, disturbed in the regularity of its dilatations and contractions; or so corroborate the fibres, or moving organs of it, as to dispose it to moderate the circulation of the blood that passes thro' it in the most advantageous manner. And that the disposition of the heart, even when men have no sense of it in the part it self, may be of moment as to health and sickness, appears credible; since a living human body, is not a mere lump of flesh, bones, &c. but an exquisitely well-contrived machine, whose parts are easily set on work by proper, tho' very minute agents; and by their action upon one another, perform far greater things, than can be expected from the bare energy of the agents that first put them into motion: whence, the disposition of the heart being, tho' perhaps insensibly, changed, it may produce a remarkable alteration in the motions of the blood, and its passage thro' that part, in point of quantity, celerity, or both.

How much this change in the circulation may, in many cases, conduce to sickness or recovery, will partly appear by the effects of vehement, or durable passions of the mind. Thus 'tis observed, that in a deep sorrow, which, in a manner, straitens the passages of the heart, the blood is too sparingly dispensed, and the enlivening spirits are not generated in sufficient plenty. The blood is hereby, also, so dispirited as, in these parts of *Europe*, to dispose the body to the scurvy, which either produces or irritates several other diseases. Thus, again, the passion of shame often suddenly alters the motion of the blood, and makes it swell the little vessels that lie under the cuticula of the face, and sometimes other parts. The like effect I have seen produced by a great and sudden joy. And tho' its opposite passion, grief, has been usually observed to deaden the appetite to meat; yet so much depends upon a regular transmission of the blood, that joy has been found in several persons, and I have known an eminent instance of it, very much to lessen hunger: which effect *M. des Cartes* ingeniously attempts to account for, from the varied dilatation and motions of the heart. And it seems not absurd, that the like motions may be caus'd by the corpuscles of a specific medicine, which, by affecting the fibres of the heart, after the manner of joy, may produce in it such amicable dilata-

MEDICINE. tations and contractions, as flow from the agreeable passions. And, what favours this conjecture, a lady of my acquaintance has complained to me, that the scent of perfumed gloves makes the blood fly to her face, and long continue to tinge it, in the nature of a blush.

In this manner, then, a specific, by peculiarly affecting the heart, may greatly contribute to introduce, or re-establish, a healthy crasis in the blood; which, being thus rectified and invigorated, may both befriend the body in general, and conduce to remove some particular diseases, by strengthening, and, perhaps too, exciting the particular part, in which the peccant matter resides, to subdue or expel as much of it as it already harbours, and to resist the accession of more. And the blood being thus brought to a good state, and the solid parts corroborated, the specific that produces these effects, may be said to cure some particular diseases, which only continue by being frequently supply'd with vitious matter from the blood in its circulation.

P R O P. VI.

A specific remedy may unite its particles with those of the peccant matter, and thereby constitute some different substance, to be easily thrown off, or safely continued in the body.

This I take to be one of the most proper and genuine methods of operation in specific medicines; because an effect is here produced, either without the assistance, or beyond the mere power of the manifest qualities of the remedy, and a cure, or relief, usually obtain'd without violence, torture, or disorder.

This manner of working in a specific medicine, is of near affinity with one or two of those formerly mention'd; but different from them in some particulars, as will appear hereafter. Sometimes, when a certain kind of acid has impregnated the blood, or lodg'd it self in some solid part of the body, the corpuscles of a specific may, without any sensible conflict, be so qualified, as to make coalitions with the particles of the peccant acid; and, with them, constitute little concretions, which, differing from the minute parts of the acid, either in bulk, figure, solidity, stiffness, motion, or in two, or more of these, may become quite of another nature, and much more innocent than the acid it self, before it was thus corrected. We are furnished with a notable illustration hereof, by digesting *Aqua fortis* with an equal, or double weight of inflammable spirit; for, by this means, I found, that highly acid liquor so chang'd, as not to retain any sensible corrosiveness; and to exchange its piercing scent, and great acidity, for an inoffensive, pleasant smell, and a grateful, and actually sweetish taste. Which brings into my mind the practice of a president of the famous college at *London*, who, as himself told me, used to relieve a patient of very great quality, of nephritic torments, by giving her a large dose

dose of an inflammable spirit. But spirit of wine, by its effects upon MEDICINE. several other acid menstrea, wherewith I mix'd and digested it, appears not to work upon them uniformly, as they are all of them acids, but differently, according to the nature and proportion of the acid corpuscles, with which the vinous spirits associate.

And to shew, that this change and contemperation of the menstruum, by the spirit of wine, is produc'd rather by a peculiar fitness of the convening corpuscles of both, than by the contrariety that the vinous spirit has to the *Aqua fortis*, as an acid; I shall add, that pure spirit of wine, mix'd in a due proportion with highly rectified spirit of urine, will greatly abate its caustic property, and with it compose a salt much more moderate than the spirit; and which, being sublimed, or rather reduced into a liquor, affords an excellent mixture, in some fevers and other diseases as a medicine: and, with a small skilful alteration, it is of great use in many chymical experiments as a menstruum.

A few grains of the glass of antimony, made without addition, being taken inwardly, will vehemently both vomit and purge; and tho' wine, if well impregnated with its corpuscles, proves a violent emetic and cathartic; yet if spirit of vinegar, that is, of degenerated wine, be, for a competent time, digested upon the glass finely powder'd, and when the liquor is sufficiently impregnated with the particles thereof, abstracted from it, there will thence arise a multitude of minute concretions, of which many grains may be given, without ordinarily provoking either vomit or stool. All mortifications, therefore, usefully made by medicines, need not be of acids; since we here see, that acids themselves may prove correctors: and, perhaps, it is by such kind of combination, that some poisons are subdued. I suspect that it may as probably be upon this account, as upon any hitherto offered, that a man, stung with a scorpion, is cured by crushing the animal upon the hurt; as an acquaintance of mine told me he try'd upon himself; and a virtuoso upon a soldier, with good success. And, considering what a multitude and variety of figures, may fit such particular corpuscles to make coalitions, very different from both the component parts, it seems probable, that in a patient's body there may be made between the corpuscles of the peccant matter, and those of a medicine, such useful combinations, as to produce concretions innocent or beneficial.

When a particle of peccant matter comes to be associated with one of a specific medicine, that combination may alter it for the better, not only by changing its magnitude and figure, but also by increasing or lessening its stiffness and solidity, and giving a new modification to its motion; as will easily appear from a little attention to the natural consequences of the coalitions of bodies.

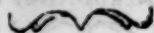
I might shew, *ex abundanti*, that the small concretions made by the union of some morbid, with some medicinal corpuscles, may not only become innocent, but sometimes beneficial, by what happens to common

MEDICINE. sublimate, from a farther preparation; for tho' this be a substance so highly corrosive and mischievous, that a few grains of it will kill a man; yet by making a coalescence, with less than its weight of quicksilver, which is a body insipid and scentless, the corrosive matter is thereby so alter'd and tamed, as to be turned into a kind of white, tasteless earth, call'd *Mercurius dulcis*; which, if skilfully prepared, and given in the quantity of many grains, is not only innocent, but a very good medicine; and that, perhaps, in more cases than physicians are generally aware of.

And this may afford us a probable argument, to shew, that, notwithstanding all the digestions and changes a specific medicine undergoes in its passage thro' the body, it may still prove salutary, when it arrives at the part it should relieve. For, tho' the corpuscles of the medicine should be considerably chang'd by the way, yet 'tis possible they may, by that very alteration, be made medicinal; since they may thus be qualified, when they arrive at the part affected, to combine themselves strictly with some corpuscles, whether morbid or others, that they find there; and with them compose new concretions, of a nature very friendly to the patient. Something analogous to this we may observe in asparagus, which being eaten, affords store of particles, that, mixing with those they meet with in the kidneys, or the bladder, produce a new odour, very different both from that of mere urine, and from that of the plant. Thus, also, if good turpentine be taken by the mouth, 'tis known, that, arriving at the kidneys and bladder, it will mix its minute parts with those it meets with there; whence emerge corpuscles, that give the urine a very different scent, from that of either of the liquors; for it often has a fragrantcy like violets.

Before I conclude this subject, it seems proper to take notice of a difficulty, that may, in general, be objected, to what has been hitherto deliver'd. It might be said, that my arguments and explanations all along suppose the specifics to be taken at the mouth; while 'tis known, that many external remedies are reckon'd among specifics, which, perhaps, do but barely touch the body, as is the case in amulets, rings, &c. But, we may take notice, that the confidence with which many physicians reject, and some of them deride external specifics, seems built upon this, that the medicine cannot get into the body; or, that in case it should have some part of it subtile enough to gain admittance, that part must be too small and inconsiderable, to produce any such great change, as is necessary to the expulsion of peccant humours, and the conquering of a disease.

In answer to the former of these suspicions; 'tis certain, that the human skin, tho' it seems an entire continued body, is really perforated with a great multitude, and, perhaps, variety of little outlets, which we call pores; many whereof are visible by good microscopes, even in the skin of dead animals; and others are manifestly inferr'd from the numerous little drops that cover the whole surface of it, at the
first



first eruption of sweat. And that these little perforations may prove inlets to the finer particles of medicines, externally apply'd, appears probable from several phenomena. Thus water will soak thro' the pores of a fine bladder, and dissolve salt of tartar, or white sugar, contain'd in it. And I have prepared a certain liquor, whose fumes, tho' not agitated by heat, would quickly penetrate several membranes of dead animals, and manifestly work on metalline bodies wrapt up in them. 'Tis a known thing, that quick-silver, outwardly applied in ointments, girdles, &c. will get in at the pores of the skin, and invade the internal parts of the body; and remain there longer, and, perhaps, operate more than the physician desired. And, when once the effluvia of these external remedies have gained admittance at the cuticular pores, 'tis not difficult to conceive how they may proceed further: for underneath the cuticula, and close to it, there are so great a multitude of capillary vessels, that you can scarce thrust a small pin into any part, but the point will meet with and tear some of them; as appears by a small drop of blood, that will issue out at the little orifice thus made. To which instance many others might be added, to shew the multitude, and branchings of the capillary vessels, that lie immediately below the skin, and, for the most part, carry blood, tho' some of them may contain other juices, and discharge their recrement by sweat, or insensible transpiration. Now, these fine capillary vessels, having their cavities immediately continued with larger, and, by their means, with greater still, which are branches of the largest of all, the corpuscles of the medicine, once got into the capillary, may have an easy passage into the branches of the principal veins; and so, by virtue of the circulation, come to be quickly mingled with the mass of blood, and thence conveyed to all the parts of the body. Thus it has been often observed, that arsenical amulets, worn upon the breast, tho' they scarce touched the skin of that part, produced terrible disorders in the heart, and several dangerous symptoms in other parts of the body. And, 'tis recorded by credible authors, that cantharides, tho' only held in the hand, or carried in the pocket, have transmitted their effluvia as far as the bladder, and there occasioned great pain, and other pernicious effects.

To the second objection against specific remedies, that if their effluvia could get entrance into the body, these are not efficacious enough to have any considerable effect upon any internal disease; I observe, first, that the number of the corpuscles which pass from the outward medicine into the body, may be far greater, and, therefore, more considerable, than most men are apt to think. This may be render'd probable, by the great multitudes of odorous, and, consequently, sensible expirations, that are continually emitted, for a very long time together, by ambergrease, musk, civet, and much more by skilful compositions of them. And, that also subtile effluvia, even without the assistance of heat, may quickly penetrate membranes so plentifully,

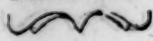
MEDICINE. as to act on solid bodies contained therein, I have experimentally seen, and made appear to others.

Secondly, that the corpuscles of a medicine may retain their nature and power of operation, notwithstanding their being strained thro' the skin. For mercury is often found in the form of quick-silver, in the dead bodies of some men, who had been frequently anointed with mercurial unguents. And, by this means, a patient may be as violently salivated, as if he had swallowed mercurial medicines. Thus I have frequently observed, that a little opium, mixed up with other ingredients for a plaister, would, by outward application, take off the acute pains of remoter internal parts.

And, lastly, that the corpuscles of a specific may, on several occasions, act more powerfully, by getting in at the pores of the skin, than if the remedy had been taken at the mouth; because its particles might, in the latter way, be divided, or greatly alter'd, by the ferment of the stomach, by their filtration in the intestines, and their long and winding passage thro' them and the lymphaducts, before they arrive at the heart, to be mingled with the blood; whilst the corpuscles of an external specific, presently after they are past the skin, get into the contiguous capillaries, and thence presently pass into the fluids, unalter'd. Whence it appears, that those physicians are much mistaken, who think a topical medicine can, at best, only relieve the part it is apply'd to.

And, what is more extraordinary, bodies, outwardly apply'd, may prove specifics for some diseases, for which, by the bare knowledge of their effects, when taken in at the mouth, they might seem not suited. Thus camphire swallowed, is, in the dose of a very few grains, a great heater of the blood; and, in some countries, extoll'd by physicians in particular kinds of ill-conditioned fevers; yet it is outwardly apply'd to take off those rednesses of the face, that are thought to proceed from a heat of blood, and used in ointments against burns. Thus, spirit of wine, which tho' so hot when drunk, is a very good remedy in burns; especially if the part be early moistned therewith. Bread, that is counted so moderate and well-temper'd an aliment when eaten, has, if chew'd and outwardly apply'd, considerable virtues in several external disorders. And I know an ancient and experienced physician, who uses to purge such children as will not easily be brought to swallow medicines, by applying something to their navels, that does not offend them by its colour, smell, or griping. And this himself, more than once, confess'd to me, is but an ordinary aliment, which most men, and I among others, have frequently taken, unprepar'd.

'Twere easy to mention a great many external specifics, from the writings of physicians; but I purposely forbear it, because, to speak freely, I suspect that most of those remedies, tho' greatly extoll'd, have been but little examined by the persons who deliver them. And

it may suffice for my present purpose, to alledge a few instances, that MEDICINE. have been recommended to me either by my own experience, or that of some friends. 

I lived in the same house with a learned and judicious person, who, being subject to paralytic fits, and to be frequently tortur'd by violent cramps, was usually, on a sudden, relieved, by wearing, or handling the tooth of a true hippopotamus, or river-horse. And he affirmed to me, that upon leaving off the use of it for any considerable time, either out of curiosity, or to satisfy some friend, the fits would return, with violence, upon him. I remember also, that having my self been, for some years, frequently subject to cramps, and complaining of it to a physician who had travelled into cold countries; he told me, that he had brought home with him some rings, made of the true elk's hoof, from a place where those animals are usually employ'd; and that with these he had cured many of the cramp: one of them he presented me to make trial with; which I the more willingly accepted, because he assured me, that several of them, sold for genuine, were either counterfeit, or of no efficacy. And, tho' I did not find, that if the cramp seized me in the calf of the leg, the ring would much relieve me; yet when the fits were but moderate, and in other parts, especially the hands, I found my self eas'd so often, and so suddenly, that I was at first surprized at it; and used to have the remedy laid, every night, by my bed-side, to be ready upon occasion. And what seemed strange, I several times found, when the cramp seized my foot, or my toes, the pain was quickly removed, tho' I only apply'd the ring to my finger.

An eminent physician, discoursing with me concerning a patient of his, that was subject to a nocturnal *Incontinentia urinae*; I told him of an empirical remedy, and which, at least, seemed safe, tho' it should not prove effectual; and it was only a simple animal substance, to be worn in a sarsenet bag, next the skin; for which the physician long afterwards gave me thanks, and told me, he was surprized at the effect thereof; but that he observed, when the patient had worn it, till probably the virtue began to decay, that is, till its effluvia were almost spent, he found occasion for a fresh remedy.

I do not affirm that these appensa, any more than other remedies, will always succeed; and I think one may assign some probable reasons for the want of uniformity in their effects. But for my present argument it suffices, that they sometimes succeed; since that is enough to shew it possible, that outward medicines may operate upon inward distempers.

A young lady was cured of a large tumour in her neck, suppos'd to be scrophulous, by barely applying to it the hand of a man, who died of a lingering disease, till she felt the coldness thereof penetrate to the innermost parts of the swelling; the operation being repeated more than once whilst the corps continued sweet. This method was advised by

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MEDICINE. one of the most candid and skilful physicians of the *London* college, who gave me this relation, and shewed me a very noble present, which he received for his advice. This remedy is mentioned by *Helmont*, and long before him, by *Pliny*; tho' its virtue generally seem'd to have been disbelieved, or forgotten, till *Franciscus Ulmus* took notice of a case very like the present; affirming, that by this remedy alone, after others had been fruitlessly employed, he knew a noble virgin to have been perfectly cured.

I was, one summer, obnoxious to frequent bleedings at the nose, for which I sometimes used one remedy, and sometimes another; and, for the most part, with good, tho' not with sudden success. But falling once into a fit, the violence whereof alarm'd me, I resolv'd to try an unusual remedy, the true moss of a dead man's skull; which had been sent as a present out of *Ireland*, where it is more esteemed than elsewhere: this remedy I did not employ in the usual manner, by putting it up my nostrils; but, notwithstanding the briskness of my hemorrhage, try'd, whether the medicine would produce its effect by being only held in my hand; by which means I found, to the surprize of the by-standers, that the blood speedily stopp'd: nor have I been troubled with it since that time. But this is far less strange, than what was affirmed to have happened to one of the most eminent members of the royal society; who, being of a very sanguine complexion, found himself so violently affected by the moss of a human skull, that sometimes, when he was let blood, if, for curiosity sake, he held a quantity of this moss in his hand, the blood would cease running till he laid it aside. This was not only solemnly averr'd to me by himself, but confirmed by his ingenious physician, with both whom I had a particular acquaintance; otherwise I should have thought the thing scarce credible, unless imagination, a faculty very strong in that gentleman, contributed to the strange effect of the remedy.

The external specifics hitherto mentioned, are afforded by vegetables and animals; which, being bodies of a slight texture, may be supposed to have their parts more volatile; I shall, therefore, produce two or three examples from the mineral kingdom; the subjects whereof are generally thought indisposed to emit effluvia.

I knew a physician, who enjoyed a good state of health, except that after a few hours sleep, he waked in the night with great terrors, followed, for a long time, by violent and frightful palpitations of the heart. To remove this disorder, he try'd all that his art suggested, but without success: happening afterwards to mention his case in a company of merchants; one of them told him, he might easily find relief, from a remedy that had been found efficacious, both upon himself and others. This he said was to take flat and smooth cornelian stones, such as they bring for rings from the *East-Indies*, and to sew eight or ten of them to a piece of scarlet cloth, or flanel, to be hung about his neck; so that they immediately touch the skin over against
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the heart and mouth of the stomach. These the physician procured, and, in no long time after, receiv'd great benefit therefrom; so that he, at length, thought, he might securely leave off the use of these stones, which he did once or twice; but finding the distemper to return each time, within a very few weeks after such a disuse; he resolv'd to keep them always on; as he had long successfully done, when he told me this story. And to convince me of the reality hereof, he presented me with some of the like cornelians. But having not yet had an opportunity to make use of them, I shall not conclude that the remedy will always succeed; but that 'tis, at least, possible such an external remedy may be very effectual.

I suspect that those, who first made use of this remedy, had the hint from what *Galen* says of the jasper; a stone, wherein we observe various colours; I my self having seen mixtures of red therein, almost as deep as that of cornelians. Of this stone, *Galen* relates, that rings were sometimes made, with a fiery dragon engraven thereon, and recommended as very friendly to the stomach, being apply'd to the mouth of it. And tho', with safety, he omitted the sculpture, he yet approves of the stones, upon his own frequent experience, wherein he apply'd them, almost in the manner of our cornelians.

I lately mention'd the efficacy of a cramp-ring, upon the *Genus nervosum*, but it seems more strange, that a stone-ring, worn on the finger, shall be able to affect the mass of blood, and particularly that deprav'd portion of it, which nature sends to the hemorrhoidal veins; yet the experienced *Monardes*, having describ'd the blood-stone, that is brought from *New-Spain*, and represented it as a jasper, not only commends it against hemorrhages, when apply'd to the bleeding part, but adds, "that he has seen some cured of the hemorrhoidal flux, by constantly wearing upon their finger, rings made of this stone"; and the same he declares of the menstrual flux. That some kinds of the *Lapis Nephriticus* are of great virtue, we have the testimony of the judicious *Boetius*, and the learned *Johannes de Laet*, whose praises of it are confirm'd by *Monardes* and others. But no author, that I have met with, speaks more home to our purpose, than a considerable merchant of *Leipsic*, whose extraordinary observations are recorded by the very learned *Untzerus*, who, among other remarkable particulars, declares, the merchant affirm'd to him, that by wearing this stone, for some days, in a nephretic case, the calculous matter was so powerfully thrown off, that a multitude of small grains of sand were expell'd at the corners of his eyes. And the like effect he had often observ'd of that remedy in several other persons. The merchant adds, that by wearing the same stone, his wife, who was troubled with a great catarrh, found it considerable cathartic; so that, the first day, she was thereby purg'd fourteen or fifteen times; the next, nine or ten times; and afterwards, had her body kept very open by its means: and that he found this stone operate as a purge, tho' not so strongly, upon himself.

Thus.

MEDICINE. Thus then, from a bare consideration of the subject, have I shewn some of the principal ways, by which, I conceive, specific medicines may cure diseases, or, at least, much lessen them. But I am far from denying, that there may be many others, whereby the same effects may be produced.

And, as I did not pretend, that a specific medicine, or nature, by means thereof, commonly effects a cure by any one of the particular ways propos'd, exclusive of the rest; but rather think, that two or more of them may sometimes concur to the effect; so neither did I propose to explain their particular ways of working; but only to shew them in general. Nor do I, lastly, assert, that the means I have pitch'd upon are the true and genuine ones, by which the medicine acts, but propose a possible one, by which it may act; so that I only offer my explanations, as possible, or not improbable; which is sufficient to answer my design in proving the notion of specific remedies, agreeable to mechanical philosophy.

S E C T. II.

*The use of
simple medi-
cines recom-
mended.*

SINCE specific medicines must, to deserve that name, be very efficacious, yet are, for the most part, either simple, or very little compounded; what we have deliver'd concerning them, affords me a proper occasion to invite the faculty of physic, to the use of such remedies, as are either simple; or, when compositions are necessary, to employ no more ingredients than are absolutely necessary to answer the indications.

This sort of simple, or lightly compounded remedies, I am induced to prefer to those crowded compositions, wherein men seem to have aimed at conquering diseases by the multitude of their ingredients; and this for several reasons. But, before I produce them, I desire the advantages, here ascrib'd to simple medicines over others, may be understood not in an absolute, and indefinite sense, but *Ceteris paribus*.

*From the ad-
vantage of
foreseeing their
effects.*

First, then, it is much easier to foresee the operation of a simple, than of a very compounded medicine; so that physicians may proceed more securely in employing the former than the latter. And, indeed, if I do not greatly mistake, we often presume too much upon our own abilities, in supposing we know before-hand what will be the qualities and effects of a mixture of many ingredients of different natures; since several bodies, by composition, and the change of texture consequent thereon, receive great and unexpected alterations. Several manifest instances of this truth, may be met with in colours, where what is produced by the mixture of bodies, appears quite different from that of any of the ingredients employ'd. As when a blue
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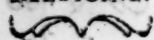
solution of copper, made in spirit of urine, produces with syrup of MEDICINE. violets, which is also blue, a fair green.

Thus, also, having put together some tincture of iron, made with good spirit of vinegar, and a volatile tincture of sulphur; from a confusion of these, two very red liquors, there immediately arose a very dark, and almost inky mixture, that retained no redness at all.

The like remarkable changes I have several times produced, by mixtures, in several other qualities of bodies, besides their colour, as in their odours, tastes, &c. And why such alterations may not be also effected by composition in some medicinal qualities of bodies, I cannot see. Quick-silver, inwardly taken, usually causes either no evacuation, or one at the mouth; but if dissolved in spirit of nitre, and precipitated with sea-salt, it yields a white precipitate; which beingedulcorated, and warily given in a just dose, seldom fails to work, not by salivation, but by stool. On the other hand, glals of antimony, whereof a very few grains, given in substance, prove violently cathartic and emetic; yet, being dissolved in spirit of vinegar, will not usually either vomit or purge; tho' the menstruum be drawn from it, and the glals given in a larger dose than when pure and unmixed.

And tho' by fluxing crude antimony with nitre and tartar, as in the ordinary way of making *Crocus metallorum*, there is produced a medicine so very emetic and cathartic, that an ounce, or less, of the wine, wherein it has been infused, tho' without sensibly losing its weight, will operate strongly, both upwards and downwards. Yet I have known some persons, who would, without scruple, take several grains of crude antimony, in substance; and one particularly, who long continued the use of it, without being vomited, or purged thereby. And trials, purposely made, have informed me, that if, instead of salt-petre and tartar, antimony be prepared with well dry'd sea-salt, and a little salt of tartar, tho' both these amount not to above half the weight of the nitre and tartar vulgarly used; yet the antimony well fluxed with these for about an hour, is thereby so altered and corrected, as to afford an useful medicine; of which may be given from twelve grains to half a dram, or more, in substance, without ordinarily working either by vomit or stool, but usually by sweat, and sometimes by urine. Whence we see, that antimony may be either made a more dangerous or a more friendly medicine, than it is of it self, according to the ingredients wherewith 'tis associated; tho' these be in themselves innocent, and, perhaps, of kin to one another. And even chymists, as well as other prescribers of remedies, sometimes add to a simple, such things as rather deprave, than improve it. Thus one of their great patrons complains, that flower of sulphur, by being sublimed from calcined vitriol, &c. under pretence of purifying and subtilizing it, really acquires a hurtful corrosiveness.

2. Another advantage of simple medicines is, that, *ceteris paribus*, Their being they are more safe than compounds, especially if the patient be vale- more safe.

MEDICINE.  tudy. 'Tis too frequent, both in herbarists and other writers on the *Materia medica*, to give us rather encomiums, than impartial accounts, of the simples they treat of. Thus they enumerate and magnify all the virtues they have, and sometimes more than they have; without taking notice of their ill qualities; upon whose account, nevertheless, they may be inconvenient, hurtful, and dangerous to some constitutions: as, in particular cases, several perfumes, tho' very grateful and refreshing to most men, are yet very hurtful to many women, and especially to the hysterical. I have known the smell of musk greatly disorder an eminent person, tho' otherwise of a robust constitution. I have also known several persons of both sexes, very much offended by the scent of roses. Wormwood, tho' for many purposes an excellent plant, has been so often found to disaffect the head and eyes, that I have, for some years, forbore it my self, for fear of the head-ach, and forewarn'd others of it whose eyes are weak. I am acquainted with a very learned physician, who, tho' he has naturally very good eyes, found, upon an obstinate trial, that the plentiful use of wormwood, in wine and beer, so greatly decayed his sight by degrees, that at length he could not read a gazette without spectacles; but by barely leaving off the use of that plant, he quickly recover'd the vigour of his eyes. This relation I had from himself, soon after the thing happened.

And I question not that we might find, upon strict enquiry into the nature of simples and medicines, many that have bad qualities, unobserved by physical authors. I have more than once foretold some hurt that patients would receive, by the use of applauded medicines, prescribed them by considerable men; when, upon their authority, my warnings were neglected, and the use of the remedies unhappily persisted in. I once saw in the hands of a learned traveller, an *Arabic* manuscript, about the *Materia medica*, the method whereof seemed more accurate than any thing I had met with on that subject. For the author had been so wary, that, after the columns wherein he taught the virtues, doses, &c. of every drug, he had a distinct one for its bad qualities, with the constitutions and diseases, wherein the use of it might be dangerous or inconvenient. I think it, therefore, reasonable to suspect, that, where a great many ingredients are blended into a single medicine, one or other of them may have different operations from those designed by the physician; and, by awakening some sleeping ferment, produce a new distemper, or excite and actuate some other hostile matter, that lay quiet before, and which would have been gradually subdued by nature, had it not been unseasonably roused, and assisted by some ingredient, that, perhaps, was, without any reason, added to the medicine. I have had so many unwelcome proofs of this in my self, that it engages me the more, to caution others against the like inconvenience.

3. Another

3. Another benefit accruing from the use of simple medicines, is, ^{MEDICINE.} that thereby the patient may, without burdening his stomach, or ^{Commodious} nauseating the remedy, take a larger dose thereof, or of that ingredient, ^{for exhibition.} wherein the virtue chiefly resides. Physicians are often obliged to stint themselves in the dose of a medicine, for fear of disgusting the patient, or oppressing his stomach. Now when there are many things heap'd together in a moderate dose of a compounded medicine, the superfluous, or less efficacious ingredients, must necessarily take up a considerable part of that determinate dose; and, consequently, leave proportionably less of the more appropriated, or useful ingredients therein.

To say, that all the ingredients crowded into a great composition, are proper, and conduce to the same purpose, is, I doubt, not always true.

If a baker, to make the best bread he can, for a person of a weak stomach, should, to wheat flower, add the meal of rye, barley, and oats; tho' all these ingredients be good and nourishing, and each of them used to make bread, yet no body would take him for a skilful baker; and but few prefer this compounded bread, to that more simple fort made of wheat alone. So to make good gun-powder, a skilful man would not, to salt-petre, brimstone, and charcoal, add wax, rosin, and camphire; tho' these are very inflammable substances as well as sulphur. And thus to prepare a cordial-water, whereof a small quantity were to be given to a fainting person, you would not, with spirit of wine, or brandy, mix mead, cyder, &c. tho' each of these be a spirituous liquor.

Gum arabic is prescribed in several compositions, as proper to mitigate the sharpness of urine; but, by reason of the quantity of the other ingredients, wherewith 'tis usually mix'd and clogg'd, no more than a small proportion of it comes to a dose; wherefore, leaving out all other things, I have given a dram, or more of it, at once, in powder, mix'd with some convenient vehicle, and found very considerable effects from it. And I remember, that a gentleman of great note, coming to bid me farewell before he entred upon a troublesome journey, to some mineral waters, for a very painful sharpness of urine; I knowing the case to be neither venereal, nor from the stone in the bladder, desired him, before he went, to make use of this powder'd gum, once or twice a day; by which means he thought himself quite cured, and forbore prosecuting his journey, not only for that year, but the next. Against the chin-cough in children, which often frustrates the endeavours of physicians, I have not known any magisterial composition so effectual, as the simple juice of penny-royal, a little sweetned with sugar-candy; and given from time to time in the quantity of a child's spoonful. There are many and obvious examples of the great efficacy of so simple a remedy as asses milk, which yet, in some cases, I think inferior to that of goats, if taken

MEDICINE. in a sufficient quantity, and for a competent time. There are also many instances of dangerous and stubborn diseases, that have been cured by common cows milk, when drunk very plentifully, and for a long time together. Perhaps, it is no less remarkable, that in a few days time, diarrheas and dysenteries are happily and easily cured, as I have sometimes known them, by the bare use of so slight a remedy as milk, wherein, whilst it is gently boiling, an equal quantity of fair water is added, little by little, till at last there remains but as much liquor, as the milk alone amounted to at first. This simple alimential medicine, being freely used for common drink, has been very frequently found to cure different kinds of fluxes, even in *Ireland*, where they are endemical. I have formerly recommended *Paronychia foliis rutaceis*, against that stubborn disease, the king's-evil; but must not here omit a notable confirmation of the utility of an alterative simple, given in a considerable quantity. A physician whom I knew, was sent for to a scrophulous patient, in whose throat he found a tumour so large, and so unluckily seated, that greatly compressing the oesophagus, it render'd deglutition exceeding difficult; the tumour was likewise so hard and stubborn, as not to be discuss'd, nor brought to suppuration; whence the patient was put in imminent danger of being starv'd. In this strait, the physician remembering the character I had given of whitlow-grass, sent about the country to get all that could be procured; and at first gave a little of it, in the form of infusion, in such liquid aliments as the patient was able, tho' with great difficulty, to get down: and having, by this means, after some time, gradually made the deglutition more easy, he gave the remedy in greater plenty, to imbue the whole mass of blood, and juices of the body, with the virtue of the herb; whereby the tumour was at length dissolved, and the patient secured.

And tho' I might here enumerate the virtues of some other simple remedies, plentifully given, I shall rather observe, in general, that several alterative simples would, doubtless, be found far more effectual than is commonly thought, if they were given in a very large dose, and continued for a competent time. And, probably, many physicians would not be so forward, as they are, to reject either specific or simple remedies, if they allow'd them as fair a trial as their own prescriptions; such as the officinal chalybeates, the *Spaw* or *Tunbridge* waters, the decoctions of guaiacum, &c. which they often give, with many intermediate helps, for a month, or six weeks, or sometimes two months together, without expecting they should perform the cure in a few days time.

Easily procurable.

4. The fourth consideration, that recommends the use of simple medicines, is, that, *ceteris paribus*, they are more easily procured than compounds. This assertion needs little proof. And, where several simples are required, one or more of them may often prove difficult to be got; and all of them will still be troublesome to form into a

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composition. How useful the knowledge of parable remedies is, I need not here endeavour to prove; but shall add, that some medicines are easily obtained, without resorting to the shops of apothecaries; since those of artificers are often furnish'd with them. Thus among masons, and bricklayers, we commonly meet with quick-lime, whose bare infusion, in common water, is, of it self, an excellent medicine in several cases; and, as experience has taught me, may be made the basis of several good remedies, both external and internal: among the latter of which, may be reckon'd an ointment, that I usually keep by me, against burns, made only by beating up strong lime water, with as much good linseed oil, as can be made throughly to incorporate with it into a white unguent.

MEDICINE.

The linseed oil, which is to be had in the shops of varnishers and painters, exhibited, alone, in a large dose, as that of several ounces at a time, I have known prove very serviceable in breaking pleuritical empyema's. Simple oil of turpentine also, that may be usually had in the same shops, is a noble remedy in many diseases. And I have receiv'd great thanks, both from physicians and chirurgeons, for recommending the use of it to them in wounds; and, particularly, where one would expect little from it, in the stanching of blood, if it be seasonably apply'd very hot to the wounded parts; whilst it also greatly promotes a good digestion. A chirurgeon to a great monarch, and one of the most skilful men I ever met with of his profession, confess'd to me, that in an admir'd cure, which he perform'd of a desperate gangrene, in an eminent person, very aged, and almost bed-rid, the medicine he ascrib'd most to, was the oil we were speaking of. And because he, and others, frequently use spirit of wine, with good success, in gangrenes, which being suppos'd incapable of mixing with oil of turpentine, I thought it might prove of service to practitioners, to be able to make a mixture of the two, that might, probably, be more penetrant than the one, and less fugitive than the other. Such a mixture I easily made, by digesting, for a while, and strongly shaking, from time to time, about equal parts of good oil of turpentine, and throughly dephlegm'd spirit of wine, till by imbibing, or dissolving, great store of the oleaginous parts, the liquor obtain'd a yellow colour; for which reason I call it the tincture of oil of turpentine.

There is another simple, to be found in the shops of colour-sellers, which, tho' very offensive to the tast, and somewhat disagreeable to the stomach, hath a very great anti-nephritic virtue. I procured it with difficulty, from a very extraordinary chymist, who, tho' a sparing commender of remedies, extoll'd this, as the best he ever met with to cure the stone, where it was not too big to pass, and to prevent the increase of it where it was. I have also known it us'd glyster-wise, with very good success, in a fit of that disease; but inwardly, I had no occasion to try it, except upon my self: and judging it innocent, as indeed I found it rather anodyne than forcing; I took it, now and
then,

MEDICINE. then, mix'd with oil of sweet almonds, to allay the tast, as a preservative from the gravel; for which purpose, I thought it more manifestly effectual, by lessening either the bulk of the grains, or the quantity of the sand, or both, than any of the remedies I had used, with the same view, for several years before; yet I scarce took a quarter of the dose, prescrib'd by the person who communicated the medicine to me. His order was, to take, from time to time, either by it self, or in some convenient vehicle, two or three ounces of the stale express'd oil of walnuts.

Before I leave the shops of tradesmen, I shall take notice of one medicine more, that seems to have been first lodg'd there, and from thence translated into the shops of apothecaries. The medicine, I mean, is *Castile or Venetian soap*; which being a body, abounding with alkaline salts, and oleaginous parts well combined, invited me to make some experiments with it, as a substance applicable to physical uses. As to its medicinal virtues, 'tis prevalent against the jaundice; for which purpose, as I have been inform'd, 'tis in great request among some skilful men in *Holland*; and experience has recommended it to me against the stone: but that for which I chiefly prize it, is its virtue in case of making bloody urine. A considerable merchant of *Cork*, in *Ireland*, being afflicted with this distemper, in so violent a degree, as to be thereby unqualified for his business; I advis'd him to scrape as much *Castile soap* into a spoon, as it would conveniently hold, without being press'd, that is, near a dram in weight; and having fill'd the vacant part, with some convenient vehicle, to swallow it, and wash it down with a large draught of the same liquor; repeating the dose twice or thrice a day, if need required. The manifest relief he found, by this seemingly despicable medicine, within two or three days, invited him to continue the use of it a while longer; by which means he has now, for some years together, liv'd quite free from his distemper, without scrupling to ride on horseback as his occasions require. This gentleman farther told me, he had advis'd the same remedy to several others in the like case, who were, likewise, happily cured by the use of it.

*And likely
to improve the
knowledge of
the Materia
Medica.*

5. The last, and principal reason, that induces me to wish physicians would employ simple remedies, as much as possible, is its being one of the likeliest ways, and, perhaps, absolutely necessary, to promote the practical knowledge of the *Materia Medica*; for, whilst a multitude of ingredients are crowded, or confounded, in one receipt, 'tis almost impossible to know, with any certainty, to which of the simples the good or bad effect of the remedy is to be ascrib'd; or whether it be not produc'd by a power, resulting from the particular qualities of them all, united under one temperament, and acting, conjointly, as a whole. So that by this method, of jumbling simples into compounds, I see not how, in many ages, men will be able to discover the true qualities of the particular bodies, compriz'd in the *Materia Medica*.

On

On the otherhand, when a physician often employs a simple, and observes its effect; the relief or prejudice of the patient, may very probably, if not with medical certainty, be ascrib'd to the good or bad qualities of that particular remedy.

And this difficulty, of discerning what particular ingredient of a very compounded medicine helps, or hurts a patient, is much increas'd to those, who affect to prescribe compositions of compounds. As when *Venice-treacle*, which, alone, consists of above fixty several simples, *mithridate*, and the like, are thrown, as so many single ingredients, into a medicine. I had once some thoughts of drawing up a discourse upon the difficulties of the medicinal art, and had provided many materials for such a work, which I afterwards laid aside, for fear it should be misemploy'd, to the prejudice of worthy physicians. But, among the difficulties that then occurred to me, I shall mention one, *viz.* that 'tis a harder work than most men think, to discover fully the nature, or the good and bad qualities, in reference to physic, of any single plant, or other simple of the *Materia medica*. For, besides the great difference that there may be in plants of the same denomination, according to the climate, the soil, the goodness of the seeds that produce it, the culture, or want of it, the time of the year, the seasonableness, or intemperature of the weather, the time and manner of gathering and keeping it, the parts of it that are, and those which are not made use of, together with numberless other circumstances; besides all these, I say, the unheeded textures of parts, that are thought of an uniform nature, and the length of time during which they have been kept, without being suspected to be superannuated, &c. may so greatly vary the nature of a plant, that I have sometimes, almost in a trice, seen a notable disparity in the parts of the same fresh leaf of a common herb. And, what is very remarkable, I have found, by trial purposely made, that some seeds, of common use in physic, will, by being distill'd at one time of the year, afford an acid spirit, or liquor; but, at another time of the year, tho' distill'd the same way, without any addition, a kind of urinous one, that contains a volatile salt; which in smell, taste, and several operations, appeared to have a great affinity with the volatile salt of urine, or that of hartshorn. And, indeed, so many things may be pertinently propos'd to be enquired into, with relation to any particular plant made use of by physicians, that, perhaps, they would be less inclined to throw numbers of them into one composition, if they were aware, how much useful employment the discovery of the qualities of a few single plants would afford them. Yet, without knowing the properties of the separate ingredients, that a physician prescribes, it will be scarce possible for him to know, with sufficient certainty, how the medicine made up of them will be qualified and operate. And I the less scruple to make this reflexion, because *Galen* himself expressly asserts, that "'tis absolutely impossible

"to

MEDICINE. "to use a compound medicine properly, without being perfectly acquainted with the virtue of the simples that compose it."

I presume it will be easily allowed, that much of what has been said in favour of simple medicines, may be extended to many of the remedies afforded us by chymistry. For, without now entering into the question, whether the spirits, oils, and salts, obtained by the fire, are principles in the strict sense of the word; it will scarce be doubted, that the spirit, the oil, or the salt of a mixed body, chymically resolved, is so slightly, or unequally composed, that the ingredient whence it takes its name, is far more predominant there, than when combined with others in the entire or uncompounded concrete. And, that such supposed principles, or medicines, of a simple order, will prove very efficacious, may be justly argued from the great and beneficial effects of oil of vitriol, spirit of urine (a medicine of great use both externally and internally) spirit of hartshorn, spirit of nitre, spirit of wine, and oil of turpentine: of which last I shall add, that, besides the virtues already ascribed to it, whilst it retains its simplicity, it may, in many cases, be employed as a menstruum; and, by being combined with an ingredient or two, be made to afford various medicines; which, tho' but little compounded, are of great virtue. For, I have found it readily dissolve camphire, mastic, and some other gums, of which balsams may be made; and others may, by the help of the same liquor, be obtained, even from several mineral and metalline bodies. I will not insist on so known a medicine as the common terebinthinate balsam of sulphur, tho' this be a remedy, which, as much as 'tis peculiarly extoll'd for diseases of the lungs, has virtues unconfined to the distempers of that part; since both I, and some I recommended it to, have found it very effectual, outwardly apply'd, in troublesome hemorrhoidal pains and tumours: and experience inclines me to think, its virtues may not be much greater in pulmonic, than in paralytic distempers; in the latter of which it may be used not only outwardly, but, to more advantage, inwardly, and that in a pretty large dose, with a cephalic, and, in some cases, an anti-scorbutic vehicle. But I shall rather take notice, that, perhaps, it will be found worth while to try, at least in external disorders, the use of several tinctures, and consequently balsams, that may be obtained by the help of oil of turpentine, from some solid mineral bodies; by which I have found, upon trial, this liquor may be tinged; and among them, I shall name, besides crude zink, crude antimony, and even crude copper, a noble subject, antimonial cinnabar; from whence, tho' I could draw a fine tincture, I had not opportunity to make trial of so promising a medicine.

That chymical remedies, also, should be simple.

6. And as for such other medicines as are not made by bare analysis, but by synthesis, or composition; tho' I think an experienced chymist may, in many cases, with less uncertainty than a *Galenist*, foresee what quality the mixed body this way produced, may have; yet

yet I could wish, that chymists were more sparing in the number MEDICINE. of the ingredients they employ, to compose a single medicine. For most of the arguments that shew the advantage of simple remedies, are also applicable to chymical ones.

In many cases, preparations skilfully diversified, may be usefully substituted for composition; since one body dextrously exposed to different operations, may acquire as various, or as considerable qualities, as would accrue to it by the addition of such other materials, as an ordinary chymist would, in all probability, associate with it. Thus, not to mention quick-silver, antimony alone, or associated with one or two ingredients, may afford a variety of medicines, capable almost of furnishing a shop; or, at least, to answer the physician's intention, when he would employ an emetic, a cathartic, a diaphoretic, a deobstruent, a diuretic, a bezoardic, or cordial medicine; to pass over the other remarkable qualities that may be found in some antimonial preparations.

Again, without bringing together a chaos, or any great number of ingredients, one or two auxiliary ones, if judiciously chosen, and skilfully managed, may often produce more efficacious remedies, than the admirers of pompous processes would expect. The violently emetic, and purgative virtue of glass of antimony, *per se*, may be, as we have seen, more powerfully corrected by mere distilled vinegar, than by many famous stomachic, or cordial elixirs, and other elaborate preparations. And, sometimes, a seemingly improper addition may not only correct, but give new and unexpected virtues to a drug. Thus, tho' corrosive sublimate be a very pernicious and fretting mercurial concrete, yet by adding, and carefully uniting to it, an equal weight of running mercury, there is thence, by sublimation, obtained a compound, which, in skilful hands, may be usefully employed, not only in some venereal affections, but in several other distempers. And this preparation, call'd *Mercurius dulcis*, being carefully made and apply'd, will greatly allay even the sharpness both of some emptying medicines, and of some peccant humours. I remember, I had an opportunity to observe its efficacy in a stubborn dysentery, that had baffled the remedies of an eminent physician. But, tho' a reflexion on the virtue I knew this medicine to have, in allaying sharp humours, and resisting putrefaction, might justly give me a favourable opinion of it in this case; yet not thinking my own experience sufficient, I imparted it to an ancient and experienced chirurgion of the army, who frankly confess'd, that this was his great *Arcanum*, where-with he had cured many hundreds of soldiers of the like distemper. But, as my way is to give from eight to fifteen grains of it, for a dose, made up with a little rhubarb, or other ingredient, that would make it work once or twice; (for the dysentery it self helps to carry off the medicine) he made it up with sugar and the mucilage of gum-dragon, into lozenges; each whereof might contain from near a scruple

MEDICINE. to half a dram, of the *Mercurius dulcis*: and of these he order'd the soldiers to take one at a time, without hindering their march; only giving them a great caution, that nothing of it should stick between their teeth, or in their throats.

But the efficacy of this simple preparation of mercury, is much inferior to that more simple one of gold, made after the same manner, in two different countries, by two dextrous physicians, both of them my acquaintance. For, tho' I had been long prejudiced against the pretended *Aurum potabile*, and other boasted preparations of gold, for most of which I have still no great esteem; yet I saw such extraordinary and surprizing effects from the tincture of gold I speak of, upon persons of great note, with whom I was particularly acquainted, both before they fell desperately sick, and after their strange recovery; that I could not but change my opinion for a very favourable one, as to some preparations of gold. But tho' this simple medicine can only be made in small quantities, and that too not without a great deal of pains and time, I can speak thus circumstantially of it, because by the kindness of the artists, and the pains I had bestowed in working upon the same subject they use for their menstruum, I so far knew, and partly saw the preparation of it, as to apply what has been said, to the present occasion. There is here but a single ingredient associated to the gold, and that comes from above, and is reputed one of the simplest bodies in nature; two or three ounces of which may be taken altogether unprepared, without the least inconvenience. Yet the dose of this almost insipid medicine, that was given to an old courtier in a violent apoplexy, after other remedies had by skilful men been used in vain, was but six or eight drops.

In another very ancient and corpulent person, the dose was greater; the tincture being then more unripe, and diluted: but the effect was as sudden, tho' the patient were not bled; and tho' there was not in either of these cases any remarkably sensible evacuation made. The two persons thus recover'd are yet alive. The same medicine, a while after, saved the life of another gentleman, whom I know, that having lain above two and twenty days sick of an ill-conditioned fever, was condemn'd by three physicians; one whereof told me, that he could not out-live the next morning; yet, upon taking of a large dose of this tincture, he was presently relieved; and from that time found a sensible amendment, and afterwards recover'd his health, which he now enjoys, tho' he was then reputed to be fourscore years old. I could relate some other odd effects of this remedy; but the present may suffice to alleviate a prejudice against medicines, made of so fixed and supposed unalterable a metal as gold.

Nor is this the only medicine, made of that noble body, of which I have known very remarkable effects. My preparation of silver, tho' it may seem but slight, has proved very effectual, and been much used by one of the most eminent physicians of this nation, to
whom

whom I recommended it, and who acknowledg'd to me, that he gave it to patients, of very high quality, tho' disguised, to avoid alarming those that are fearful of chymical medicines. And since that, I gave it, with great success, to a lady, who was hydropical, and judg'd to be dangerously ill; and the cure has already, for some years, held good. But, I confess, that I look upon copper, and its magistery, blue vitriol, as a much nobler subject to make remedies of, than silver, or, perhaps, than gold it self. And if I were to make physick my profession, there is no metal, which I should so willingly bestow pains upon, as copper. And to this I am induced by the excellent, and very extraordinary effects that I have seen of some remedies, which, tho' I could never learn how to make, I knew were compos'd of that metal, or the purified vitriol abounding in it. And for appeasing of pains, produc'd by inveterate distempers, the laudanums, and other preparations, prescrib'd, and praised by physicians, seem to me, because of the stupor they induce, and some other inconvenient symptoms, far inferior to the sulphureous parts of skilfully prepared copper; these being much more harmless and friendly anodynes. And, I remember, that an empiric, to whom I communicated a very uncertain way of making a kind of sulphur of vitriol alone, in the form of a brick-colour'd powder, came purposely to give me thanks for the reputation he had gain'd by that medicine. Of this, the first time, he had the good luck to make it, he gave four or five grains to a woman, that could not sleep, and that had been, for several months, raving mad; which single dose, not only procur'd her a good nights rest, but brought her to talk sense, when she wak'd in the morning. I knew a chymist, who was much courted by learned physicians, for an internal anodyne he used, and could sell at, almost, any rate, to take off inveterate pains in the head, and shins of venereal patients; the same person cured venereal ulcers in a very short time, only by strewing on them an indolent powder; and tho' he was exceeding shy of his medicine, I happen'd to get a sight of it, and guess'd, by its weight and effects, that it was some preparation of mercury, fix'd with sulphur of copper. Whereupon he frankly acknowledged, that tho' it would endure a strong, and lasting fire, that, in the former part of my conjecture, I was in the right; and in the latter, shot very near the mark; but added, that the true sulphureous parts of copper were, in his way, so difficult to be obtain'd, and required so much time, that he could seldom prevail with himself to go thro' so troublesome a work. And, in effect, I found, upon various trials, the constituent parts of that metal to be much more strictly united, than the generality of chymists imagine. *Helmont* says; that "nothing has a greater effect upon the radical moisture, than the *Ens primum* of copper; and nothing more powerful to prolong life, than the sulphur of vitriol". Both physicians, and chymists, make a great variety of remedies of steel; some of which are produced by slight preparations; and the like may be

MEDICINE. said of mercury; witness the remedy, formerly commended against worms, made of nothing but crude quick-silver, barely boiled in common water: and the calx of lead, dissolv'd in spirit of vinegar, affords *Saccharum Saturni*; which, tho' so easy and simple a preparation, is a magistery that has more virtues than every physician knows, or, perhaps, suspects; especially in mortifying sharp humours in the eyes; which I have known it sometimes do, almost in a trice, when well diluted with plantain, or rose-water. And for burns, I have seldom seen any thing equal to it; and, therefore, have often used it upon my self, barely dissolv'd in common water: but, I fear, 'tis not so safe, as effectual, in some internal disorders of the *viscera*, judg'd to proceed from acid humours, unless it be warily and skilfully given. But, as to its external use, it is very powerful in healing, and, in the mean time, appeasing the pains of several sorts of ulcers. A very antient, and experienc'd chirurgeon, confess'd to me, that of all the medicines he has tried to stop bleeding, and prevent accidents in amputations; that which he most rely'd on, was a solution of *Saccharum Saturni*, in plantain, or common water. His method is, to dissolve an ounce of the former, in about a pint of the latter; and as soon as ever the limb is taken off, immediately to apply stupes, drench'd in this liquor, as hot as the patient can well endure: and having bound them carefully on, he makes no hast to take them off, but allows the medicine time enough to perform its operation.

What is here said of metals, may be extended to minerals; for when there is need to compound them, it may often be sufficient to associate them with one or two auxiliary ingredients. This appears from several useful preparations of antimony, commonly known; to which several others may be added, that are made by slight additions of commonly sulphur. But of this sort I shall only mention one, whose medicinal virtues are very great, especially in asthma's and coughs, in which I do not remember, that I ever gave it, without benefit to the patient; nor was it less successful in the hands of physicians, who were willing to try it for me; especially in those of a person, who, tho' well furnish'd with choice remedies of his own, often came to me for a supply of this spirituous and penetrating tincture, with which he assured me he did notable things in asthmatical cases; and particularly in one, that was very obstinate, and had lasted many years. This medicine is made of the flowers of sulphur, exactly mix'd with an equal weight of sal-armoniac, and more than an equal weight of good quick-lime, separately reduced to fine powder. These three ingredients being diligently and nimbly mix'd, and put into a retort, fitted with a large receiver, well luted to it, and duly distill'd in a sand heat, will afford a blood-red and smoaking spirit, exceeding sulphureous, both in smell and mechanical operations. And, in this distillation, we found the sulphureous parts sometimes came over accompanied with such store of saline ones, that a good part of
what

what pass'd into the receiver, shot into the form of a volatile, MEDICINE.
sulphureous salt.

7. It may be objected, against the frequent use of simple medicines, that a disease, or the morbid matter, is, often, not the effect of a single cause, but produc'd by the concurrence of two or more, which, creating several symptoms, 'tis improbable that one simple will be able to answer the several indications. This objection is, I confess, considerable; and there are cases, wherein I acknowledge it to be so weighty, as to warrant a physician to employ a medicine, consisting of several ingredients. But this interferes not with my design; since I formerly declar'd, I was not for confining any one to simple remedies, but wish physicians would only employ them where they may suffice.

Whether simple remedies may cure complex distempers.

Two or three considerations may, however, be offer'd, to lessen the force of the present objection. And first, I readily grant, that sometimes diseases may proceed from different causes; and that a remedy may be available against them, when produced by one of those causes, without being so when they flow from another; yet it may easily happen, that in one case the disease may be cured by one single medicine, and in another, by a remedy not compounded. Nay, it is possible, the same simple may cure a distemper, by which soever of the two causes it is produced. And the effects of the *Peruvian* bark, in different kinds of agues, and of narcotic medicines, in appeasing pains produced by humours, and other very different causes, render this assertion probable. And, if I mistake not, it may frequently happen, that, whatever first produced a portion of morbid matter, this very matter may cause the continuance of the disease, by means of some peculiar texture, or noxious constitution, which if the generous medicine can destroy, the disease will cease.

It often happens, that several very different symptoms may so depend upon the primary cause of the disease, that if a medicine, how simple soever, be able to destroy that cause, all the various symptoms will vanish of themselves. Thus we see, that when mercury is skilfully apply'd, and raises a kindly salivation, a great variety of inconveniencies, that afflicted a venereal patient, and seem'd to require many different and topical applications, are remov'd by the same remedy; so that not only frightful ulcers, but such nodes as one would think scarce possible to be dissipated by the strongest plaisters, are sometimes happily cured by well prepared quick-silver, taken at the mouth. And tho' there are several, and, sometimes, very different symptoms, that accompany the rickets; yet the medicine, which I call *Ens veneris*, made of strongly calcin'd, and well dulcify'd colcothar of *Dantzic* vitriol, and elevated with sal-armoniac into the form of a reddish sublimate, has prov'd so successful, that I think I may safely say, two or three hundred children have, through my means, been

MEDICINE. been cured by it, and that, almost, always without the help of any other inward medicine, or topical application.

But the principal thing I oppose, by way of answer, to the objection is, that in a simple medicine, nature, her self, often renders the use of compositions unnecessary; for tho' we are apt to look upon a plant, or mineral, as an entire and simple body, yet we may greatly mistake, if we look upon it as homogeneous. In several plants, that are organical bodies, as, for instance, in oranges, the succulent part is sour and cooling, but the yellow rind considerably hot and bitter; and so in lemons, the pulp, the yellow part of the rind, and the seeds, have their different qualities and medicinal virtues: and even in such vegetable substances, as are homogeneous as to sense, there may be parts, whose operations are not only different, but contrary; as is manifest in rhubarb, which affords as well astringent as purgative parts. This holds, also, in minerals; thus good clean lead-ore, for instance, tho' an uniform body, as to sense, consists of very dissimilar parts, and affords sulphureous, and, perhaps, other recrements, besides malleable lead, which is it self a compound body. Thus, also, shining marcasites, tho' they appear homogeneous, will, by being barely expos'd, for a competent time, to the moist air, afford an efflorescence perfectly vitriolate; and consequently contains an acid salt, two kinds of sulphur, a terrestrial matter, and, at least, one metal; which latter substances themselves, are neither of them simple bodies.

And if we admit the chymical analysis of mix'd bodies to be genuine; we shall find that almost all those belonging to the vegetable kingdom, or to the animal, and many that are referred to the mineral kingdom, how uniform soever they may appear to the eye, do, each of them, contain different, and sometimes opposite substances. Thus hartshorn, tho' it appears a dry and homogeneous matter, will, in distillation, afford a volatile salt, an urinous spirit, a waterish liquor, or phlegm, an oil that will swim, and another that will sink in water, a white and porous earth, or *terra damnata*, and, perhaps, some fix'd salt. Thus, also, in the vegetable kingdom, tartar, for instance, may, without addition, be made to afford a volatile salt, very like that of urine, a phlegm, an acid spirit, another spirit, which I call a-diaphorous, two fetid oils, whereof one will sink in water, and the other swim, a *terra damnata*, and a fix'd lixivial salt, upon which the acid spirit manifests such an hostility, that when put together, they tumultuate, with noise and bubbles, and in the conflict, mortify each other. So, likewise, in the mineral kingdom, we see native cinnabar affords, by distillation, besides running mercury, a dry substance, whence I have obtain'd a sulphur, that would, presently, gild silver, and a terrestrial matter, whose nature I did not examine. And I the rather take notice of these differing parts, in native cinnabar, because it is a mineral that I much esteem; and tho' here in *England* it is very rarely employ'd as an internal medicine, yet I know some physicians,

sicians, of several nations, who look upon it as one of their chief *MEDICINE*. *ARCANA*, and both use and conceal it accordingly. But I do not willingly employ this material, till it has been prepared by grinding upon a porphire, as a painter would do to make a pigment of it; and by freeing it from certain salts, that often, undiscernedly, adhere to it, and may sometimes prove hurtful. This is done by first washing it very carefully with boiling water; and then, after it has been thoroughly dry'd, by burning upon it, several times successively, some vinous spirits perfectly dephlegmed. The dose, if it be to be long continued, is three, four, or five grains; but when 'tis given seldom, and on urgent occasions, from six to twelve grains.

8. Since a simple then, whether organical or not, may, notwithstanding its entireness, or seeming uniformity, contain or afford very dissimilar parts; and being therefore really a compound body, it may afford parts different enough to answer differing indications in the cure of diseases. Thus, in many diarrheas, where 'tis judged requisite to evacuate the peccant matter, and then to give astringents to hinder the immoderate evacuation, wherein the disease is thought to consist; rhubarb answers both these indications, by its purgative and more terrestrial parts; the former whereof dispatch their work first, which makes the astringent operation of the latter safe and seasonable.

I have often observed, that so common and despicable a simple as ground-ivy, has performed things, whose variety seem'd to argue, that it contains parts of very different virtues; and is thereby capable of answering different intentions, especially in distempers of the lungs and breast: and, indeed, partly by the syrup of it, partly by the infusion of the leaves, and partly by medicines made of them in a consistent form, the happy effects of this plant have procured me the thanks of many considerable persons; some of which had before unsuccessfully try'd many prescriptions of learned men. And I remember the master of a considerable manufacture, was very much incommoded and perplexed, to find his servants obnoxious to violent colics, which he imputed to the copious steams of the vinegar his art required; but from this inconvenience he was, at length, in great part, freed, by making them frequently use a strong infusion, or tincture, of the leaves of ground-ivy, prepared with good *Nantz* brandy.

I could here add many other uses, both internal and external, of this seemingly despicable plant; and there is scarce any *English* herb, for its virtues manifested in the experience of others, and my own, that shares so much of my esteem, as ground-ivy. And I am apt to think, that the virtues of this, and some other simples, would be found more numerous and powerful than is generally allowed, if physicians, in their prescriptions, would more frequently either ordain simples, or join but very few together; and compensate the smallness of the number, by the greater quantity of those that are the most proper or operative; and order the use hereof to be continued for a compe-

tent

MEDICINE, tent time. 'Tis not, indeed, every efficacious simple, or lightly compounded remedy, that can be fitly employed for the proof of our doctrine; I shall, therefore, subjoin a few such instances, as may suffice for the present occasion.

Mineral waters, whether *Acidula*, as those of the *German Spaw*, our *Tunbridge*, &c. or *Therma*, such as those of *Bath*, &c. tho' but natural medicines, are, some of them, by being outwardly administred, known, singly, and in their native simplicity, to cure several diseases; and, consequently, to take off a great number of different symptoms, which afford various indications. That the same simple may comprize qualities fit to answer different designs, and, therefore, cure different symptoms, seems probable; because several poisons, that do, each of them, produce various frightful symptoms, all which have been often conquer'd by a specific antidote, that is, perhaps, but a simple herb, or other uncompounded drug.

Physicians, and others, have observed great variety of symptoms in the plague; among which there are several, each whereof, if single, would pass for a particular disease; and this diversity of symptoms may be often observed, not only in pestilences, that happen at times, or countries, distant from one another, but in the same plague reigning in the same place. Yet 'tis possible for a simple remedy to prove available against this so various and violent a disease. *Galen* himself, treating of the *Terra Samia*, takes occasion to bring in the virtues of *Bolus Armena*. This earth, which appears so simple and uniform, he not only commends for several diseases, as spitting of blood, fluxes of the belly, dysenteries, catarrhs, defluxions, difficulty of breathing, and even ulcers of the lungs; but adds, what makes directly for our purpose, that "in a very severe plague, all who took this medicine early, recover'd." "Twas taken," he says, "mix'd with small white-wine, diluted in proportion to the fever." He also declares, that "if this remedy failed to relieve the patient, every thing else proved ineffectual."

There are few diseases that appear in so many forms, with greater variety of symptoms, than that which physicians call *Affectio Hysterica*, whose paroxysms are vulgarly known in *England* by the name of fits of the mother: yet we have often suddenly removed these fits, by the bare odour of spirit of sal-armoniac.

But to shew the efficacy even of dry and solid bodies, tho' but externally apply'd, in diseases, attended with many uncommon symptoms, we might have recourse to the stones, said to be found in the heads of a certain kind of serpents about *Goa*, and some other *Eastern* countries. Most physicians, however, reject or question the power ascribed to them, for curing the bites of vipers: and, indeed, many of the stones brought from *India*, are counterfeit; and of those that were really taken out of serpents, several will prove insignificant; (and such, perhaps, were those that the learned *Rhedy* made his trials with;) yet there

there are others, whose virtues cannot well be deny'd. For one of MEDICINE.
the most eminent physicians of the *London* college assured me, he had
with one of these stones, contrary to his expectation, performed a
notable cure, which he related to me, at large. And a very famous
English chirurgion affirmed to me, that he had done the like upon
another person; both of these cures being performed by the bare appli-
cation of the stone, to the place bitten by the viper. A very intelli-
gent person, also, who had the direction of a considerable company of
traders in *East-India*, where he long lived, assured me, he had with
this stone cured several persons of the hurts of venomous animals.
But this testimony is much less considerable, as to the number of
cures, than that of a great traveller into the southern parts of the
same *India*; who seriously assured me, he had cured above sixty persons
of the bites or stings of several sorts of poisonous creatures; and that
he performed most of those cures by the outward application of one
stone; because, finding it excellent, he was invited to keep to it, espe-
cially in difficult cases. And this, some experience of my own, made
with a genuine stone of the same kind, upon the bodies of brutes,
much inclines me to give credit to.

I had once the opportunity of making a trial of the virtue of a
stone, taken out of the head of an enormously great *African* serpent.
This stone was affirmed to its possessor, the governor of the *English*
East-India company, to be highly available against the bites of all veno-
mous animals. And, indeed, a little of it recover'd a cat from two
dangerous bites of a fierce and enraged viper, after we had despaired
of his life, on account of the violent symptoms that ensued.

But because this stone is afforded by an animal, I shall, for a conclu-
sion, add the virtues of another, that properly belongs to the mineral
kingdom, in a disease, whose symptoms, tho' not so various, are some-
times dangerous, and too often mortal.

There was once shewed to me a close and hard solid body, which pass'd
for a blood-stone, tho' by its colour, and some other visible qualities,
I should rather have taken it for an agate, about the bigness of a small
nutmeg, that had been long kept in the family wherein I saw it; being,
for its rare virtues, transmitted from one to another. I shall not relate
all the reports made of this stone; but I think the following particu-
lar of it is very remarkable. An ingenious gentleman, in the flower
of his age, and of a complexion very highly sanguine, was, from time
to time, subject to hemorrhages at the nose, so profuse and difficult
to be restrained, that his physician, tho' a person famous, and very
well skill'd in his art, told me, he often fear'd he should lose his patient.
But when a good method, and variety of remedies had been try'd,
without the desired success, this stone was, at length, obtained to tie
about his neck, so as to touch his naked skin; which being done in
the fits, it would stop the bleeding; and if he wore it for some con-
siderable time together, he all that while continued well; as both his

MEDICINE. physician, and himself informed me. And because I was apt to ascribe somewhat of this effect to imagination, the patient told me, that a while before, one of the chief women in the city fell into so violent a bleeding, that tho' it made her swoon, yet the hemorrhage still continued, till the stone having been tied about her neck, stopp'd it; whilst she knew nothing of its being apply'd. And this is still less strange, than what the gentleman affirm'd to me of the power of the same stone; for his complexion inclining him to breed great plenty of blood, his physician order'd him, by way of prevention, to breathe a vein from time to time; but, in preparing for this operation, he was obliged to lay aside the stone, because the blood would not otherwise issue with the requisite freedom.



SOME

S O M E

Uncommon Observations

U P O N

VITIATED SIGHT.

i. **A** Gentleman, who was almost blind, from a blow he received upon his head, told me, that tho' he could not well distinguish colour'd objects, yet he clearly perceived those that were white; which shews, there is a greater quantity of light reflected by white objects than others. And I had the like affirm'd to me by another person, who was almost blind. *White objects, the most visible, to a dim sight.*

2. I knew a gentleman afflicted with a cataract, which, when I looked on his eye, in a light place, appear'd to cover almost the upper part of the pupil; and tho' he were young and vigorous, he could not, in the clearest weather, well discern men from women, cross a street. This misfortune proceeded from a great blow he received, on the same side of his head; which circumstance I note, because when no outward violence has been offer'd to the eye, an eminent oculist observes, and I have seen an instance of it, that a small part of the pupil left uncover'd by the cataract, would serve for a greater share of vision, than this gentleman enjoyed. But, even in this case, he also could distinguish white objects better than others.

3. Meeting, accidentally, with a man, whose eyes appeared very oddly, I question'd him about his distemper; and found by his answers, that he had been afflicted with cataracts in both his eyes, which were either ill couched, or he had not managed himself regularly afterwards. For, there seem'd still to remain ragged films, that cover'd considerable portions of his pupils, so that I wonder'd to see him walk about without assistance: he said, however, that he could read a large print, by the help of his cataract-spectacles; but, upon producing a book, I found he could not make out the title-page, because the place happen'd

MEDICINE. to be too light; which, tho' it appear'd improbable, yet having caused the room to be a little darken'd, I then perceiv'd he could read well enough.

4. A gentleman having received a violent blow on the side of his head, found, afterwards, a great weakness and dimness of sight to ensue; and looking attentively upon his eyes, I plainly discern'd, that tho' above half the pupil of one eye remain'd uncover'd; so that when he look'd downwards, he could see very well with that eye; yet there were grown in it two cataracts, which, when carefully view'd in a good light, I plainly perceived to be distinct; the one of them seeming to be smoothly spread, as if its circular edge adhered closely to the inside of the eye; the other, which seem'd not quite of the same colour, hanging loosely, and like a rag, at some distance above it.

Objects appearing dark and double.

5. A learned gentleman coming once to visit me, with design to learn my opinion, concerning an odd distemper he had in his eyes; I found, by discoursing with him, that tho', when he look'd on things near at hand, he saw them somewhat dimly, but single; yet there were some objects, particularly posts and rails, which when he beheld at a certain small distance, they appear'd to him both dark and double. He also, complain'd of many black flies, and little leaves, which pass'd, now and then, before his eyes; which tho' they do not always foretel a true cataract; since I have observ'd them to continue many years without more than a bastard suffusion ensuing; yet in him they were, probably, fore-runners of a true cataract; because I have known it observ'd, by a skillful oculist, that persons, before the formation of their cataract, have complain'd they saw objects at some distances almost double; so that looking at the head of a man, they thought they saw a great part of a dark head a little above it: which phenomenon, whether it proceed from some refractions made by the yet unequally opaque matter of the cataract, not having opportunity to examine, I dare not venture to say.

Cataracts happily couch'd.

6. It may be worth observing, how long the more kindly sort of cataracts, tho' they hinder the sight for a time, as a thick curtain drawn over the pupil, may remain in the eye, without spoiling the optic nerve, or destroying vision, after the distemper is remov'd. I remember, among other instances, a woman told me she had cataracts in her eyes so long, that she was deliver'd of six children, successively, without being able to see any one of them, till after she had been couch'd; upon which, she could read a small print, with spectacles. And several considerable persons, of my acquaintance, saw one, of eighteen years old, born with cataracts in both her eyes, who had been so happily couch'd, as thence to receive the benefit of sight in them both.

Both eyes concern'd in real vision.

7. It has, of late, been the opinion of very learned men, that tho' both our eyes are open, and turn'd towards an object, yet but one of them at a time, is effectually employ'd, in giving us the true representation

sentation of it. But there will be a variation herein, according to the several habits and constitutions of the eyes of different persons. For I have, by an experiment, purposely made, several times found, that my two eyes together, beheld an object in another situation, than either of them apart would do. On the contrary, I met with a person, who told me he had a cataract in his eye, for two or three years, without finding any impediment in his sight; tho' others had, during that time, taken notice of a white film that cross'd his eye, till, at length, happening to rub his sound eye, he was surpriz'd to find himself in the dark; upon which, an oculist assured him, it was a cataract. But a very ingenious person, had, by an accident, one of his eyes struck out, who told me, that, for some months after, he was apt to mistake the situation and distance of things; for, having frequent occasion to pour liquors out of one vial into another, after this misfortune, he often spilt them, and let them run quite beside the necks of the vials, he thought he was pouring them directly into. Another gentleman, also, who had, by a wound, lost the use of one of his eyes, confess'd to me, that, for some time after, he often, in pouring out his wine, miss'd the mouth of the bottle, or glass, that should receive it. A yet more considerable instance, of this kind, I met with in a noble person, who, in a fight, had one of his eyes strangely mangled by a musket-ball, which came out at his mouth; for he told me, that he could not well pour drink out of one vessel into another, and had broken many glasses by letting them fall out of his hand, when he thought he had given them to another, or set them down upon the table: he added, that this aptness to misjudge of distances and situation, continued with him, tho' not in the same degree, for little less than two years. I have often employ'd a dextrous artificer, whose right eye is constantly drawn so much aside, towards the greater angle, that the edge of the pupil, almost, touches it; whence one would think it scarce possible, but he should see objects double with two eyes, that seem so very differently turn'd; for the other remains natural; yet he finds no inconvenience from hence, except deformity, for he reads as freely as other men. This disorder beset him thro' mistaking sublimate, for another thing; after which, it seems, one of the muscles, that moved the eye, remain'd contracted. But as he had been thus, ever since he was two years of age, he could not remember whether he had seen objects double, before he was accustomed to judge of them by the help of his other senses, and the information of others.

8. 'Tis worth observing, that a very great distention may be made of the parts of the eye, without spoiling of the sight. Of this I lately saw an instance in a patient of that experienced oculist, Dr. Turberville. A gentlewoman about two and twenty years of age, whose complexion and features would have render'd her handsome, had it not been for that sort of eyes which some call ox-eyes; for they were swelled so much beyond

The parts of the eye capable of great dilatation, without prejudice.

MEDICINE. beyond the size of human eyes, that she complain'd they often frighted those who saw her; and were, indeed, so big, that she could not move them to the right hand, or the left, but was obliged to look straight forward; or if she would see an object that lay on one side, she was oblig'd to turn her whole head that way. And this was her case when she went to read; unless, with her hand, she mov'd the book from one side to another, to bring the ends of the lines directly before her eyes. She said her eyes were not always equally tumid, and that the day I saw them, they had been, in the morning, much more swell'd. But, what is more remarkable, she could, for all this, not only see very well and distinctly, but her sight continued good, tho' this distemper had been upon her for twelve years. Nay, she declar'd, that when this disorder first came on, she knew of nothing that was amiss in her eyes, till her friends told her of it, after they found it of too long a continuance to be a casual tumour. It, however, occasioned great pain in her eyes; for which she took several medicines with so little success, that both she, and her former physicians, thought the case desperate: upon which I propos'd a salivation; but the modest patient would by no means consent to it.

A dimness of sight in the day-time.

9. I once look'd into the eyes of a gentlewoman, where I could discern nothing amiss, or unusual, except the narrowness of her pupils, which is often esteem'd a good sign; yet she was much troubled with fumes, and weakness in her head; and had a very uncommon disorder in her sight: for in the day time, she said it was so dim, that she could hardly discern her way; but that soon after sun set, and during the twilight, she saw far better: and thus she continued for a long time. This brings to mind an odd case of an old learned divine, who complain'd to me, that, during the day time, his right hand shook so much, that he could not manage his pen; and, therefore, was forc'd to make use of it only by candle light. I remember, that upon his pressing me to assign some possible cause of so odd a phenomenon, I told him, to put him off, that, perhaps, the few animal spirits he had to move his hands with, were so subtle, as to be dissipated, or exhal'd, by the warmth of the day, but were kept in by the coldness of the night, that constricted the pores; and thereupon recommended to him the use of strengthening things; and among the rest, of chocolate; which, having continued to drink, for some time, he came and told me, with joy, that he began again to be able to write in the day; and so, I think, he still continues to do.

The appearance of fire passing before the eyes.

10. Being acquainted with two ladies, of very different ages, but very near of kin, who were both of them troubled with distempers, that made me guess their eyes might, sometimes, be oddly afflicted; I learnt, upon inquiry, that one of them, often thought she saw numberless sparks of fire, that were very unwelcome to her; and the other, who was subject to convulsions, tho' not epileptic, told me, she fre-

frequently saw, as she fancied, the like flashes of fire pass before her eyes, which at first greatly affrighted her. MEDICINE

11. A gentlewoman about twenty years old, in whose eyes, tho' I could discern nothing unusual, or amiss, said, that, about five years before I saw her, having been, upon a certain occasion, immoderately tormented with blisters, applied to her neck, and other parts, she was quite deprived of her sight; that, some time after this, she began to perceive the light, but nothing by the help of it; that, then she could see a window, without discerning the panes, or the bars thereof; that, afterwards, she grew able to distinguish the shapes of bodies, and some of their colours; and that, at last, she could see the minutest object: and presenting her a book, she not only, without hesitancy, read in it a line or two, but having pointed with my finger at a place of the margin, near which there was the part of a very little speck, that might almost be cover'd with the point of a pin, she readily found it out; and shew'd me at some distance from it, another yet more minute, that required a sharp sight to discern it. 'Twas now about noon; but she told me she could see much better in the evening, than in any lighter time of the day. I asked her, if the letters of the paper I shew'd her, appeared black to her, and the paper white. To which she answer'd, that they did so; but that she saw, as it were, a white glass laid over both the objects. Two things were particularly odd in this case; for first, she is often troubled with flashes of lightning; that seem to issue out like flames, about the external angle of her eye, and often make her start, put her into frights, and give her melancholy thoughts. Secondly, which is more strange and singular, she can distinguish some colours, as black and white; but not others, especially red and green. And when I produced her a bag of a fine glossy red, with tufts of sky-coloured silk, she looked attentively upon it, but told me, that, to her, it did not seem red, but of a dark or dirty colour; and the tufts of silk, she said, seem'd to be of a light colour, which she compared to the colour of the silken stuff of the lady's petticoat, who brought her to me: and, indeed, the blues were very much alike. She further said, that the meadows did not appear green, but of an odd darkish colour; and that when she had a mind to gather violets, tho' she kneel'd in the place where they grew, she could not distinguish them, by the colour, from the grass about them, but only by their shape or touch. And the lady who was with her, took thence occasion to tell me, that when she looks upon a *Turkey* carpet, she cannot distinguish the colours, unless of those parts that were white or black. I asked, whether she were not troubled with female obstructions; to which she answer'd, not now, but formerly very much.

12. I lately convers'd with a mathematician, eminent for his skill in optics, whose organs of vision are so constituted, that, tho' in his eyes I could discern nothing unusual, and tho' he makes frequent use of

Colours appearing different to disorder'd organs

MEDICINE. of them in astronomical observations, and optical experiments, yet he confess'd to me, that there are some colours which he constantly sees amiss; and particularly instanced in one which seem'd dark to him, whilst to me and others it appear'd quite different.

13. A lady, who has been long troubled with a very unusual disorder in her head, and who, tho' she looks well, is never without pain in that part, told me, that after violent fits hereof, which she has suffer'd from time to time, if she did but turn her eyes, suddenly, from one side to the other, a convulsive motion in one of them would presently ensue; upon which, all white objects, and most others she look'd on with that eye, appeared green. And yet this was not a transient discomposure that would go quickly off, but continued for a good while, and frequently return'd upon her, for a whole year together; so that she despair'd of recovering the use of that eye, wherewith she, nevertheless, sees now very well; tho' her cephalic distempers are not quite cured. And if she goes to read whilst the convulsion is upon her, the letters are so apt to appear double, that if she resolves to continue reading, she is obliged to shut the distemper'd eye, and employ only the other.

A great dilatation of the pupilla in the dark.

14. There was a gentleman of great courage and good parts, major to one of the regiments of king *Charles I*; who being afterwards forc'd abroad, ventur'd, at *Madrid*, to do his king a piece of service, of an extraordinary nature and consequence, and there judg'd very irregular. Upon this he was committed to an uncommon prison, which had no window belonging to it, only a hole in the wall, at which the keeper put in provision, and presently clos'd it again on the outside; but not perhaps very exactly. For some weeks, this gentleman continued in the dark, very disconsolate, but afterwards he began to think he saw some little glimmering of light, which, from time to time, increased so, that he could not only discover the parts of his bed, and other such large objects, but, at length, perceived the mice that frequented his chamber, to eat the crumbs of bread which fell upon the ground, and discern'd their motions very well. Several other particulars of his sight in that dark place he related; but when, after some months, the face of affairs was changed, and this gentleman set at liberty, he durst not leave his prison on the sudden, for fear of losing his sight by the dazzling light of the day; and, therefore, accustomed his eyes to it by slow degrees. This relation I had from the gentleman's own mouth.

A
COLLECTION
O F
REMEDIES,

Gain'd from particular experiments,
made in the curative part of medicine.

TIS here my design to communicate the receipts of such medicines, as, by competent experience, have been found serviceable. Physic, indeed, is not my profession, yet I hope I may publish a collection of remedies, without incurring the censure of equitable persons; since 'twas a regard to the good of mankind that induced me to it. And did such a practice stand in need of precedents and examples to patronize it, very eminent persons, both among the ancients and moderns, would abundantly afford them.

*The nature
and design of
this collection.*

The major part of the following receipts is, chiefly, design'd for the use of the generality, and those who cannot well procure the assistance of a physician; and because such persons are more frequently exposed to external injuries, as strains, bruises, tumours, &c. I purposely procured, from eminent surgeons and practitioners, a number of remedies, that, having been found very effectual in such cases, might be useful in this collection. However, I am not so much an empiric, as to recommend any remedies for certain and infallible cures, in the cases wherein they are proper. He must either be very happy, or very little vers'd in physic, who has never found the most celebrated medicines ineffectual. And, indeed, the causes and complications of diseases, and the constitutions of patients, are so various, intricate, and obscure, that 'tis extremely

MEDICINE. difficult, for the most experienced physician, to make an accurate experiment in the curative part of his profession. I, therefore, solemnly profess, that I do not set down medicinal experiments, with the same positiveness I do those in philosophy; nor venture my reputation upon the success of any receipt, or process in medicine. These, however, I always deliver faithfully; nor have I, upon uncertain rumours, recorded the virtues of particular remedies; which may be good without being infallible. And we must not be so weak, or fearful, as to persuade our selves, if a patient miscarries after the use of remedies, that the fault was in the medicine. For, in spite of our endeavours, the peccant matter will often be translated, and the constitution impair'd; and the conflict of struggling nature, and the conquering disease, must sometimes manifest it self in horrid symptoms; which the envious, or ignorant, unjustly ascribe to the remedy: not considering that the like phenomena attend desperate diseases, and dying persons, where no remedies at all are administred.

I must further declare, that I do not pretend the remedies I communicate, should be physic and physician too; or of themselves cure the diseases for which they are recommended. For, medicines are but instruments in the hands of a physician, and require skill to manage them. I am, therefore, surprized at their boldness, who venture to practise physic barely upon the confidence of good receipts. Whoever acts as a physician, should, at least, have a competent knowledge of anatomy, the history of diseases, of the *Materia medica*, and the chief ways of compounding several ingredients into medicines, of different forms and consistencies, as circumstances may require. He who has only one good receipt for a distemper, and knows not how to vary it, by occasionally adding, omitting, or substituting other parts of the *Materia medica*, must frequently suffer his patient to languish helpless; or attempt to cure him of one disease, by throwing him into another. I know, for instance, some eminent physicians, who cure very stubborn venereal cases, by a chymical preparation of sarsaparilla, guaiacum, &c. but if these gentlemen meet with such patients, as *Eustachius Rudius* often did, to whom guaiacum would immediately give so great a sharpness of urine, and inflammation of the urinary parts, as to hazard their lives; they must be reduced, as well as he was, to use mercurial, or other remedies.

It, also, sometimes happens, that the very form of the medicine order'd in the receipt, renders it unfit, or impossible to be administred. A physician of my acquaintance was call'd to a patient, seiz'd with such a constriction of the parts serving to deglutition and speech, as render'd her wholly unable either to swallow, or to speak; and thus she continued for several days, notwithstanding some emetic preparations that were put into her mouth; till, at length, a glyster was luckily prescribed, with four ounces of the infusion of *Crocus metallorum*; upon which, there soon followed some violent vomitings, and a freedom of speech,

speech and swallowing. And since this, a young gentleman and fellow-traveller of mine, was taken in the same manner; so that he was apprehensive of being starv'd in a very few days: and doubtless he had soon died, if a very happy physician had not, by an effectual specific medicine, externally applied, seasonably relieved him. MEDICINE.

I would not, however, that a physician's skill should make him despise good receipts; for we have often seen, not only empirics and surgeons, but even ladies and old-wives, with a lucky receipt, perform more constant and easy cures of a particular distemper, than even learned physicians by their pompous and artificial prescriptions. The illustrious lord *Verulam* takes notice of it as a deficiency, that receipts, approved by long experience, are not more closely and religiously adhered to. And the experienced *Crato* doubts not, that a try'd remedy, rationally applied, may sometimes prove more effectual, than an extemporaneous one judiciously prescribed, by the most expert physician.

But if a medicine be powerful and commanding, the efficacy of it may supply a great want of skill in the prescriber. And, indeed, there are certain preparations and compositions of medicines so lucky, and beyond expectation successful, that the physicians who prescribed them, may write down an hundred others, each apparently as rational as any of these, which, nevertheless, shall be all much inferior to the first. 'Tis, therefore, no wonder, that learned physicians have highly valued some particular receipts and processes.

Upon the whole, 'tis rational to expect, that the nobleness of medicines will be advanced, as the art of preparing them shall be promoted; but ordinary receipts, without an ordinary measure of skill in physic, are not rashly to be relied on; especially in acute diseases: yet if there be noble and extraordinary specifics, that work rather by strengthening and restoring nature, and resolving the morbid matter, than by irritating, weakening, or disordering her; the administration of such remedies may, perhaps, usually require only common discretion, and the observance of such directions as may be given along with the medicine.

Thus much I thought fit to premise, that my design in publishing the following collection of remedies, or medicinal experiments, might not be misunderstood or perverted.

A plaister for aches, especially if scorbutic.

1. Spread thinly upon very fine kid-leather, the *Emplastrum de mucilagibus*, and let it lie upon the aching part, as long as there is need. Remedies for aches.

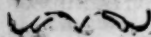
For an old ach or strain.

2. Take of *Lucatellus's* balsam one ounce, of oil of turpentine one dram; incorporate them very well, with a gentle heat, and anoint the part affected therewith; wearing on it a piece of unwash'd flanel, besmear'd with the same ointment.

H h h h 2

For

MEDICINE.



For scorbutic aches, especially about the share-bone.

3. Take two parts of palm-oil, and one of oil of camomile; mix these exactly, and therewith anoint the part affected.

A powerful remedy for scorbutic aches.

4. To one ounce of oil of turpentine, put one dram or two, of the volatile salt of hartshorn, or as much as, being well ground with it in a marble mortar, will bring it to the consistence of a kind of ointment; with which, the cold being taken off, the part affected is to be lightly anointed.

For slight scorbutic aches or pains.

5. Anoint the pained part, from time to time, with fasting-spittle; and if you will have the medicine a little stronger, the patient may put roch-alum, to the bigness of a small pea, into his mouth, before he employs his spittle.

For aches, and pricking pains in the sides, or elsewhere.

6. With a sufficient quantity of clean sulphur, finely powder'd, mix as much Venice-treacle, as will bring it to a consistence for pills. Of this mixture you may give the quantity of a pistol-bullet, twice or thrice a day; drinking any convenient liquor after it.

For acidities in the blood.

Acidities.

7. Take coral, the clearest and reddest you can get, and reduce it to an impalpable powder. Of this give the patient, once or twice a day, as need shall require, about one dram at a time; and let him long continue the use of it.

To bring away the after-birth.

After-birth.

8. Give about 30 drops, or any number between 25 and 35, of good essential oil of juniper, in a draught of any convenient vehicle.

An external medicine, often successfully try'd for agues.

Agues.

9. Take five, seven, or nine (for 'tis pretended it must be an odd number) of the roots of rib-wort; and having made them clean, put them into a little bag of sarsenet, or fine linen, and let the patient wear it upon the nape of his neck; renewing it within two, three, or four days, if need require.

A try'd remedy for agues.

10. Take of the bark of saffaras-root, and of Virginia snake-weed, both in powder, of each ten grains; and with half a dram, or two scruples of mithridate, or Venice-treacle, make a bolus; to be taken two hours before the cold fit.

Medicinal Experiments.

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MEDICINE.

A choice medicine for aguish distempers.

11. Take of salt of wormwood fifteen grains, crabs eyes eight or ten grains; mix these well, and give them in two or three spoons-full of some cordial-water.

A wrist-plaister for agues.

12. Spread wax, to about the thickness of a crown-piece, and of a convenient breadth and length, to make an entire wrist-plaister; upon this display the leaves of the tops of rue, not yet fully open'd, so that they may cover the whole plaister; then apply it, and let it lie on for several days, successively.

An often try'd medicine for agues.

13. Gather the leaves of rib-wort, as near the root as you can, in a dry morning; wipe them clean, but do not wash them; then dry them carefully, till you may reduce them to powder. Of this give from one dram to two, mixt with one dram of conserve of roses, the crumbs of white bread, or the yolk of an egg or two.

For agues, especially tertians.

14. Give as much *Virginia* snake-root, reduced to fine powder, as will lie upon a shilling, in a glass of sherry, just before the beginning of the cold fit; repeating it once or twice if need be.

For a tertian ague.

15. Of the root of angelica powder'd, give from half a dram to a dram, in any convenient vehicle, about two hours before the cold fit.

A medicine with which a quartan was cur'd, when the bark had fail'd.

16. Let the patient take one dram of the black tips of crabs-claws, reduc'd to exceeding fine powder, in any convenient vehicle or conserve, twice or thrice a day, as he would take the *cortex*, without intermitting.

To prevent or cure an ague.

17. Take grated angelica-root, flowers of antimony, of each half a dram, canary three ounces: infuse them in a cold place for two days, and pour off the clear for two doses. It is a singular good vomit for the cure of agues of all sorts, being given in the morning fasting, four or six hours before the fit; and if it be not a quotidian ague, on the intermitting day.

An often try'd pericarpium for agues, especially tertians.

18. Take a handful and a half of fresh rue, half a handful of fresh sage, a small spoonfull of bay-salt, and a spoonfull of good vinegar. Beat all these very well together into an uniform mass; which divide
into

MEDICINE. into two parts; and make thereof two wrist-plaisters, to be apply'd before the fit; and renew'd, if there be occasion, and kept on till they grow dry and troublesome.

An amulet against agues, especially tertian.

19. Cut a handful of groundsel small, put it into a square paper-bag, about four inches every way; pricking that side which is to be next the skin, full of large holes; and cover it with some fine linen, that nothing may fall out. Let the patient wear this upon the pit of his stomach; renewing it two hours before every fit.

An often try'd remedy for an ague.

20. Boil yarrow in new milk, till it be tender enough for a cataplasm. Apply this to the patient's wrists, just when the cold fit is coming; and let it lie on till the fit is gone; and if another fit comes, use fresh cataplasms as before.

For an ague.

21. Take the bone, called *Paella*, of the knee of a dead man; and having reduced it to fine powder, give of it as much as will lie upon a six-pence, for one dose, in any proper conserve, or vehicle, before the cold fit.

For agues.

22. Take salt of carduus, and salt of wormwood, each fifteen grains, tartar of vitriol half a scruple; mix them, and give them in a few spoonsfull of *Rhenish* wine, or of some other convenient vehicle, either before the fit, or at some other time when the stomach is empty.

For taking off the fits of agues.

23. Give of good common brimstone, reduced to a subtile powder, one dram and a half, or two drams, either made up into a bolus with a little honey, or in any appropriated vehicle; let it be given at the usual times, and repeated once or twice, if need be, especially if the fits should return.

A medicine almost specific for agues.

24. Take rosin of scammony twelve grains, diaphoretic antimony, and crystals of tartar, of each eight grains; mix these carefully, and give them for one dose, an hour before the fit comes.

For an ague.

25. Take the soot of a baker's chimney, mustard, rue, white-wine vinegar, sallad-oil, some white pepper and ginger; make a poultice of them, and lay it to the pulse of the arms, and let it lie on for a fortnight or three weeks.

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An often try'd medicine for tertian agues.

26. Take of alum and nutmeg powder'd, of each about half a dram; mix them with about six grains of saffron; and give this in two or three spoonsfull of white-wine vinegar, at the usual time.

An experienced remedy for an Anasarca, or general dropsy of the whole body.

27. Fry fresh rue with oil of walnuts, till it becomes fit to be apply'd, *Anasarca* hot, as a cataplasm, to the navel; and keep it on that part for some hours; renewing it once or twice a day, if need require.

A powerful remedy in apoplectic fits.

28. From the herb mastic, distil by an alembic, with a copper body, an essential oil; of which, with such a pipe or quill, that one end may be open'd and stop't at pleasure, blow up some drops first into one of the patient's nostrils, and then into the other. *Apoplexy*

To prevent and check the apoplexy.

29. Make an issue at the meeting of the sutures, and keep it long open; but if the case will not admit a delay, clap on a good cupping-glass, without scarrification, or with it, as need shall require, upon the same concurrence of the sutures.

An experienced external remedy in apoplectic fits.

30. Fix a cupping-glass, without scarrification, to the nape of the neck, and another to each shoulder; and let them stick on for a competent time.

An experienced remedy to prevent apoplectic fits.

31. Make, at the crossing of the sutures, an issue, with diapalma and oil of vitriol; and keep it open the ordinary way.

To strengthen the stomach, and promote the appetite.

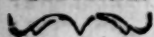
32. Make the roots of gentian pulverable, with no more waste of the moisture than is necessary; reduce them to powder, of which let the patient take from twelve or fifteen grains, to double that quantity, or more, twice or thrice a day. It may be taken on an empty stomach, or, if that cannot conveniently be done, at meal-times. It is very good, not only in want of appetite, but for obstructions: and I have usually given it in vertiginous affections of the brain; and to lessen, if not quite take away, the fits of agues, and even quartans: but, in this case, the dose must be considerably augmented. *Appetite de- proved.*

An often try'd remedy for the asthma.

33. Take soap-boilers lees one part, spirit of wine rectified two parts; fet them in digestion, and add some drops of chymical oil of carraway, and of aniseeds. The dose in younger persons is about ten drops; and in elder ones, from half a dram to one dram, in some convenient vehicle. *Asthma.*

For

MEDICINE.



For a dry or convulsive asthma.

34. Take choice saffron, reduced to a kind of powder; and with any convenient mixture, give eight or ten grains of it, in the form of pills, at bed-time.

For asthmatic coughs.

35. Take two ounces of oil of sweet almonds, fresh drawn, and put it upon one dram of flowers of brimstone; keep them, for a fortnight, in digestion, in a moderate heat, and then decant off the oil, or pass it through a clean linen rag, to keep back the brimstone: and of this liquor give a spoonfull or two at a time.

A medicine for dry or convulsive asthma's, and for costiveness.

36. Give, at bed-time, eight or ten grains of choice saffron, grossly pulverized, in a little syrup or conserve of violets.

For most asthmatic distempers.

37. Take of the roots of elecampane, thinly sliced, one ounce; of the leaves of ground-ivy a handful. Boil these in three pints of spring-water to a quart; strain the decoction, sweeten it with a little live honey, and let the patient take thereof six or seven spoonfull at a time.

For most asthmatic distempers.

38. Take juice of hyssop, and choice honey, of each two pound; mix, boil, scum, and make a syrup; of which give four spoonfull, or more, morning, noon, and night.

For the bloody-flux.

Bloody flux.

39. Dry pigs-dung, and burn it to grey ashes; of which give about half a dram for a dose; drinking three spoonfull of wine-vinegar after it.

For the bloody-flux and pleurisie.

40. Grate to fine powder the dry'd pizzle of a stag; and give of it as much as will lie upon a shilling, once or twice a day, in any convenient vehicle.

An experienced medicine for a dysentery, or bloody flux.

41. Give about three ounces of the juice of ground-ivy, mixt with one ounce of the juice of plantain, once or twice a day.

To stop a dysentery, or bloody-flux.

42. Make up the powder of fufs-balls, with some conserve of roses, or other convenient substance, into pills; and of this mixture give as much in the dysentery, as contains from about a scruple, to half a dram of the powder.

For

For dysenterical fluxes.

43. Take good *Venice* turpentine, and, with a very gentle heat, evaporate it so far, that, when cold, it may almost coagulate. Incorporate this substance with fine sugar, enough to make it up into pills, whereof give, in the morning fasting, as many as will amount from a scruple to a dram of the turpentine.

An experienced remedy for dysenterical fluxes.

44. Take the thigh-bone of a man, calcine it to whiteness; and having purg'd the patient with an antimonial medicine, give him one dram of this powder for a dose, in some good cordial.

For the dysentery, and fluxes caused by sharp humours.

45. Take from half a scruple to one scruple of *Mercurius dulcis*, and as much fine sugar; and with some purgative, let the patient take it once a day; with care that none of it remain in his mouth or throat.

An often try'd medicine for fluxes of the belly, tho' bloody.

46. Give for a dose, in any convenient vehicle, as much powder'd pizzle of a stag, as will lie upon an ordinary half-crown piece.

An effectual medicine for dysenterical and other fluxes.

47. Take of the skin, liver, gall, and all the parts, except the muscles, of a hare; and having dry'd them so, that they may be conveniently reduced to powder, give of it from about two scruples to one dram, in any convenient vehicle.

For a bloody-flux.

48. Take half an ounce of *London-treacle*, and an ounce of conserve of red roses; mix them together with some syrup of clove july-flowers, or of citrons, and keep them thus mix'd in a cover'd pot. Take of the electuary about the quantity of a walnut, night and morning, for two days, fasting two hours before and after; then intermit a day, and take it again in the like manner.

An often try'd remedy for the dysentery, and sharp fluxes of the belly.

49. Give from 15 to 20 grains of *Mercurius dulcis*, well prepar'd, and incorporated with about an ounce of catholicon, or one scruple of torrified rhubarb.

For the bloody-flux, or other fluxes.

50. Take of *Japan earth*, and powder of rhubarb, each equal parts; and give half a dram at a time, every morning, fasting.

MEDICINE.

An often try'd medicine for the bloody-flux, good also in pleurifies.

51. Give one dram of the seed of flix-weed, in two or three spoons-full of any convenient vehicle, once or twice a day.

An approved medicine for the bloody-flux, good also for pleurifies.

52. Give two or three scruples of hare's blood, beaten to powder, for one dose, in a spoonfull or two of mint-water.

A very often experienced remedy, for dysenteric and other fluxes.

53. Boil the quantity of a walnut of the fresh warm dung of a hog, and as much fine mutton suet, sliced thin, in a porringer of new milk: when these are well incorporated, strain them through a clean linen cloth; sweeten it with loaf-sugar, and let the patient take the medicine warm, once or twice a day.

To purifie and sweeten the blood.

Blood to purify. 54. Take the *Minera* of Hungarian, or other choice antimony, and having ground it to very fine powder, without suffering it to touch any metal, give of it from ten grains to a dram, once a day, at dinner, that it may mix with the aliment.

To cleanse the blood, and strengthen weak patients.

55. Take of vipers, reduc'd to fine powder, one ounce, diaphoretic antimony half an ounce, clear yellow amber two drams, starch as much as all the rest, and of sugar as much as of starch; make them into a fine paste with spirit of wine, and then form them into small cakes, whereof one may serve for a dose.

To resolve extravasated blood.

Blood to resolve, when extravasated. 56. Spread the powder'd root of burdoc, upon a linen cloth, and bind it quite round the part affected; renewing it twice a day.

To strengthen the bowels.

Bowels to strengthen. 57. Let the patient, from time to time, swallow a clove of garlic or two, without chewing.

To reduce flabby breasts to a good shape and plumpness.

Breasts, their disorders to cure. 58. Take green hemloc well bruis'd, and reduced to a kind of cataplasm, to be apply'd, gently warm'd, to the parts, and kept on till it hath performed what was intended; shifting it once a day.

For ulcers in the breast, or elsewhere.

59. Take millepedes, or wood-lice, and having wash'd them clean, with a little white-wine, and dry'd them with a linen cloth, beat them
very

very well, in a glass or marble-mortar, and give, for the first time, as much MEDICINE. juice, as you can, by strong expression, obtain from five or six of them. This juice may be taken in small ale or white-wine, in which, the next time, you may give as much as can be squeez'd out of eight or nine millepedes; and so continue, increasing the number that you employ by two or three at a time, till it amount to twenty-five or thirty; and, if need be, to forty or more, for one taking. And if, upon pounding of these insects, the mass they afford be too dry, you may dilute it with a little white-wine, or ale; that, being penetrated, and so softned by the liquor, the mass may the better part with its juice.

An often try'd cataplasm to break a sore breast.

60. To the yolks of 4 eggs, take 4 ounces of live honey, mix them, by grinding, well together, with about half a pint of claret-wine; and apply this mixture, as a poultis, to the part affected.

For an outward bruise.

61. Apply to the part affected, purified honey, spread upon cap-paper; to be kept on, with some convenient plaister, or bandage, and shifted once or twice a day. Bruise.

Or,

62. Beat aloes succotrina to fine powder; and pour on it as much rose-water as may dissolve a great part of it. This done, stir them well for a while; and when the mixture is settled, pour off the liquor, and in it dip linen-rags, which being applied to the part affected, will soon stick to it; and seldom need be removed, till the patient is reliev'd: and then, to get them off, the rags must be well wetted with warm water.

For a fresh bruise.

63. Take fresh butter and parsley, of each a sufficient quantity, and having chopt the herb, mix it very well with the butter, to the consistence of a cataplasm; to be apply'd, warm, to the bruised part.

For a bruise, or coagulated blood.

64. Take black soft soap, and with a sufficient quantity of crumbs of white-bread, very well mixt with it, make a paste, which is to be laid on the part, with a linen rag, and kept bound upon it for some hours; that it may have time to resolve the congeal'd blood, and bring the contused part from a livid to a red colour.

A powerful medicine for bruises, and several other affections.

65. Dissolve in rectified spirit of wine, as much pure camphire as you easily can; and keep it very close stoppt. To use it, moisten thoroughly some thin pieces of linen or flannel therewith, and apply them luke-

MEDICINE. warm; and, likewise, you may, with a rag dipt therein, apply it to the eye-lids; taking care that none of it get into the eye itself, since there it would cause great smart. It may, also, be very usefully apply'd to burns; and yet more so to bruises.

For burns.

BURNS.

66. Take goose-grease, and having softly melted, and a little skimm'd it, squeeze into it as much freshly exprest juice of ground-ivy-leaves, as, by continual stirring, will bring it to the consistence of a green ointment. With this anoint the part affected, and afterwards lay on it fine old rags, well dipt in the same ointment.

For burns, and stanching of blood.

67. Dissolve a large proportion of sugar in rain-water; and with a sufficient quantity of linseed-oil, or oil of olives, beat up this liquor till the oil be brought to the consistence of an unguent, with which anoint the part affected as soon as possible; renewing the application occasionally.

A very often experienced remedy for burns.

68. Take two parts of oil of walnuts, and one of honey, mix them well together over a gentle fire, and when they are thoroughly incorporated, dip a feather in the mixture, and therewith anoint the part affected, so that the ointment may touch it immediately; and then strew on it some powder of ceterach, or spleen-wort; keeping the part quiet, and defended from the air.

Against burns.

69. Beat onions into a soft mass, and apply them, as speedily as possible, to the part affected; and keep them on it till they begin to grow dryish; and then, if need be, shift them, and apply fresh.

For a fresh burn.

70. Beat a sufficient quantity of onions, very well, with common salt finely powder'd, to be applied, as a cataplasm, warm, to the part affected; renewing it, if need be, till the impression of the fire be taken out.

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An excellent ointment for burns and scalds.

71. Take of the inner rind of the elder-tree, and of fresh sheep's-dung, without any adhering straws or foulness, of each one handful; and with fresh butter, or oil, make thereof an ointment, to be applied as usual in such cases.

An approved remedy for burns, especially recent ones.

72. Take a sufficient quantity of adders-tongue, and gently boil it in linseed-oil, till the liquor be strongly impregnated with the herb; then strain it, and keep it stop'd for use.

An excellent ointment for burns and scalds.

73. Take of *Saccharum Saturni* half a dram, of the sharpest vinegar four ounces; make a solution of the former in the latter, and add, drop by drop, (often stirring, or shaking them together) as much oil of elder as will serve to reduce the mixture into the form of a liniment.

For a burn.

74. Mix lime-water with linseed-oil, by beating them together with a spoon; and, with a feather, dress the burn several times a day.

For a burn or scald in the eye.

75. Take the mucilages of quince-seed, flea-wort, linseed and fenugreek-seed, of each one scruple; boil them very lightly in 4 ounces of betony-water; filter and apply it to the part.

An approved medicine for a cancer, not broken.

Cancers

76. Take dulcify'd colcothar, and with cream, or the whites of eggs, beaten to a water, bring it to a cataplasim; which ought to be made large, and spread about the thickness of half a crown, and applied warm to the part affected; shifting it, at least, once a day.

For a cancer in the breast.

77. Take of the warts that grow on the hinder legs of a stone-horse, dry them gently till you can reduce them to a powder, of which you may give half a dram for a dose in any convenient vehicle. And to resolve hard tumours in womens breasts, apply to the part turnips-boiled, and made unctuous with fresh hog's lard.

A very often experienced medicine for cankers in the mouth, and elsewhere.

Cankers

78. Take flowers of sulphur one ounce, roch-alum, crude and finely pulveriz'd, half an ounce; mix these very well together, and incorporate them with as much good honey, as will serve to bring the mixture to

MEDICINE. to the consistence of a liniment, to be apply'd, from time to time, to the part affected.

A try'd medicine for chilblains.

Chilblains.

79. Take thick fresh parings of turnips, and hold them to the fire till they be very crisp; then apply them to the unbroken tumours or blisters, as hot as the patient can endure; keep them on for a competent time, and apply new if need require. They will cause the peccant matter to transpire, or otherwise waste, without breaking the blisters.

A remedy for chilblains.

80. Take a turnip, roast it well under the embers, beat it to a poultis, apply it very hot to the part affected, and keep it on for 3 or 4 days; or shift it twice or thrice, if occasion require.

For the chin-cough, and stuffing of the lungs.

Colds and coughs.

81. Make syrup of peny-royal, or of ground-ivy, moderately tart with oil of vitriol; and of this let the patient take, very leisurely, about a quarter of a spoonfull from time to time.

For coughs, especially such as proceed from thin rheums.

82. Take of choice olibanum finely powder'd, from one scruple to half a dram, and mix with it an equal weight of sugar-candy; let the patient take it at bed-time, in the pap of an apple, for several nights together: it may, also, be taken occasionally, at any other time when the stomach is empty.

An approved remedy for a cold, especially if it affects the breast.

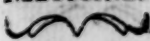
83. Take a sheet of brown paper, of an even texture, and anoint it uniformly over, and very well, with old tallow, so that the paper may be thoroughly penetrated by it: then cover it thinly with Nutmeg, and clap it warm to the pit of the stomach, that it may reach far both above and beneath it.

An experienced medicine for coughs.

84. Boil good turnips in water, and having express'd the juice, mix it with as much finely powder'd sugar-candy, as will bring it into a kind of syrup; of which let the patient swallow a little, as gently as he can, from time to time.

A medicine, which cured a gentlewoman, who had, in vain, taken much physick for a consumptive cough.

85. From ten or twelve fine raisins of the sun, take out the little kernels, and stuff the raisins with the tops of rue; and let the patient swal-

swallow them, either as they are, or in the form of a bolus, early in MEDICINE. the morning; fasting after them for two or three hours at least. 

A powerful medicine to ripen coughs, and hasten the expectoration of phlegm.

86. Cut onions into slices, and fry them with fresh butter, as if you were to eat them; then boil them with new milk, till it be well impregnated therewith, and they be made tender. Of this mixture let the patient take a moderate quantity from time to time.

An excellent remedy for a cough.

87. Take of virgin-honey two ounces; of red roses, warily dry'd, and finely powder'd, half an ounce; of choice sulphur, very well sifted, two drams; of good benjamin reduced to fine powder one dram; beat and mix all these very well; and let the patient take the quantity of a nutmeg thereof, from time to time.

For a cough, especially if accompanied with a tickling rheum.

88. Take equal parts of finely powder'd olibanum, and Venice-treacle; incorporate them exactly, and of this mass form pills of what bigness you please. Let the patient take about half a dram, at bed-time, or, if need be, one scruple, or more, twice a day.

An experienced balsam for coughs, consumptions, old strains, bruises, aches, &c.

89. To one part of good flower of brimstone, put four or five, in weight, of oil-olive, and boil them together in a large earthen vessel, till the sulphur is perfectly dissolved, with the oil, into a blood-red balsam; stirring it carefully all the time. When this is outwardly applied, it should be well warmed and chafed into the part affected; or lint being dipt in it, may be kept upon the place. It may, also, be taken internally at any time when the stomach is not full, either roll'd up in sugar, or mixed with any convenient vehicle, from two to fifteen or twenty drops. This remedy has proved serviceable in consumptions, and, externally, in fits of the gout.

A remedy for the colic.

90. In a draught of any convenient liquor, dissolve about one dram of good salt of tartar; and let the patient take it for a dose. *The colic.*

For the colic.

91. Take clean white chalk, dry'd, and reduced to fine powder; wet this with the express'd juice of camomile, and let it dry in the air, without the heat either of the fire, or of the sun. This done, wet it again with new juice of camomile, and dry it the second time, as before. Wet and dry it again the third time, or even a fourth time; then again reduce

MEDICINE. reduce the dry mass to fine powder: and of this powder let the patient take at a time, as much as will lie upon a six-pence, in a proper vehicle.

For the colic and several other distempers.

92. Take 4 or 5 balls of fresh stone-horse dung, and let them steep, for about a quarter of an hour, in a pint of white-wine, in a vessel well stopp'd, that the liquor may be richly impregnated with the more volatile and subtile parts of the dung; strain, and give of it from a quarter to half a pint, or more at a time; the patient having a care not to take cold after it.

An approved medicine for the colic.

93. Mix about half a dram of mastic, with the yolk of a new laid egg; and give it to the patient once or twice a day.

An experienced medicine for the colic.

94. Take of good nitre one ounce, rub it well in a clean stone-mortar, with half a scruple, or more, of fine saffron; and of this mixture give about half a dram for a dose, in three or four ounces of cold spring-water.

A mixture for fits of the colic, and some kinds of convulsions.

95. Take one ounce of flower of sulphur, and as much sugar-candy; grind them very well together in a stone mortar, and upon this quantity drop thirty drops of oil of carraway-seeds, as much oil of oranges, and as much of the oil of aniseeds: incorporate these well, and of the mixture give about twenty or thirty grains for a dose.

An incomparable medicine for the colic.

96. The yellow peel of oranges being reduced to powder, give from half a dram to two scruples of it, in any convenient vehicle.

An often experienced medicine for the colic, especially if produced by sharp humours.

97. To a quart of claret, put about two ounces of nettle-seeds; stop the bottle, and keep it in boiling water, a little, to assist the wine's impregnation with the finer part of the seeds: and of this liquor let the patient take a small draught once or twice a day.

A good purging drink for the colic.

98. Take two ounces of rhubarb, four ounces of gentian, and a quart of good aniseed-water; let the roots infuse long in it, and give the patient about two spoonsfull at a time, as often as need requires.

An

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A medicine almost specific for a fit of the colic.

99. Take about half a dram of the express'd oil of nutmegs, commonly called oil of mace; dissolve it in some spoonsfull of good wine, which the patient is to take as hot as conveniently he can.

A try'd remedy for colics, good also in fits of the mother.

100. Take dry ginger, and cut it into thin slices; with these fill a pipe, and receive the smoke, as you would that of tobacco. Do this twice, thrice, or four times a day, but especially at bed-time, and in the morning.

An excellent medicine for convulsive colics.

101. Take of the volatile salt of pigeons-dung two or three grains, or more; mix it with a scruple, or half a dram of the same dung crude, but slowly dry'd, and finely powder'd. Give this mixture for one dose, in some spoonsfull of any convenient vehicle.

For the colic, or pains in the sides.

102. Take two balls of fresh horse-dung, and infuse them for twelve hours in good white-wine, in a close vessel; then strain the liquor, and let the patient take five or six ounces of it at a time.

For the colic.

103. Boil about one ounce of the seeds of black stinging nettles, in a quart, or more, of good claret-wine; strain the decoction, and give of it a wine-glass full at a time, twice or thrice a day.

An excellent medicine for the colic.

104. Take of Dr. Stephens-water, plague-water, juniper-berry-water, of each half a pint, powder of rhubarb two ounces; mix these together, shake the bottle, and take about 4 spoonsfull at a time.

For the colic.

105. Give of orange-peel dry'd and powder'd, a spoonfull at a time, mixed, with a little white sugar, in any convenient vehicle.

A good medicine in pains of the colic or stone.

106. Take half a pint of salad-oil, and as much sack, or claret-wine; shake them very well together, and give them, moderately warm, for a glyster.

MEDICINE. reduce the dry mass to fine powder: and of this powder let the patient take at a time, as much as will lie upon a six-pence, in a proper vehicle.

For the colic and several other distempers.

92. Take 4 or 5 balls of fresh stone-horse dung, and let them steep, for about a quarter of an hour, in a pint of white-wine, in a vessel well stopp'd, that the liquor may be richly impregnated with the more volatile and subtile parts of the dung; strain, and give of it from a quarter to half a pint, or more at a time; the patient having a care not to take cold after it.

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Medicinal Experiments.

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A try'd remedy for colics, good also in fits of the mother.

100. Take dry ginger, and cut it into thin slices; with these fill a pipe, and receive the smoke, as you would that of tobacco. Do this twice, thrice, or four times a day, but especially at bed-time, and in the morning.

An excellent medicine for convulsive colics.

101. Take of the volatile salt of pigeons-dung two or three grains, or more; mix it with a scruple, or half a dram of the same dung crude, but slowly dry'd, and finely powder'd. Give this mixture for one dose, in some spoonsfull of any convenient vehicle.

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For the colic.

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105. Give of orange-peel dry'd and powder'd, a spoonfull at a time, mixed, with a little white sugar, in any convenient vehicle.

A good medicine in pains of the colic or stone.

106. Take half a pint of sallad-oil, and as much sack, or claret-wine; shake them very well together, and give them, moderately warm, for a glyster.

MEDICINE.

An approved medicine for inveterate scorbutic colics, and pains of the bowels.

107. Take *English* barley, well wash'd, and boil it in a sufficient quantity of fresh spring-water till it be ready to burst; then pour off the clear, upon the yellow part of the rinds of lemons, fresh cut from the white, and put them into a bottle, carefully stopp'd, for constant drink.

To make lime-water useful in several distempers.

Consumptions.

108. Take one pound of good quick-lime, slake it in a gallon of warm water, and let it stand till all that will subside be settled at the bottom, and after separation, the water swim clear at the top; at which time, a kind of thin, brittle substance, like ice, will cover the surface of the liquor: as soon as the water is thus sufficiently impregnated, pour it off warily, and keep it well stopp'd for use.

A lime-water for consumptions and obstructions.

109. In a gallon of cold lime-water, infuse saffras, liquorice, and aniseeds, of each 4 ounces, choice currants, or sliced raisins of the sun, half a pound. The dose is 4. or 5 ounces, to be taken twice a day.

A very nourishing aliment, that hath recovered many in consumptions.

110. Boil eight or ten craw-fishes, after the blackest gut or string is taken out, in barley-water, till they become very red; then take them out, and beat them long, shells and all, in a marble-mortar, and in a press, strongly squeeze out the juice; which may be given either alone, or mixt with about an equal part of chicken-broth, or some such convenient alimental liquor.

For convulsions, especially in children.

Convulsions.

111. Take earth-worms, wash them well in white-wine, but so as they may not die in it; then dry the worms, with a moderate heat, upon hollow tiles, that they may be conveniently reduced to powder; to one ounce of which add some grains of amber-greece. The dose is, from one dram to a dram and half, in any convenient vehicle.

For convulsions in children.

112. Give the patient from 2, 3, or 4, to 5, 6, or 7 grains, according to the child's age, of the true volatile salt of amber, in any proper vehicle. But this medicine is not so efficacious in full grown persons.

A remedy that has cured many children of convulsive fits.

113. Put two or three drops of chymical oil of rosemary, into half an ounce of sack; stop the vial, and let it be well shaken, to make a whitish mixture of the liquors, just before you give it. Or else in a half-

half-pint vial, put 4 ounces of sack, or some appropriated liquor, and drop into it forty drops of the forementioned oil; and whenever you are to exhibit the medicine, shake the vial, and presently give of the whitish mixture a child's spoonfull. MEDICINE.

A successful medicine for convulsions, and hysteric fits.

114. Hang the liver of a hare up in a dry place till it be dry, having a care that it putrefie not; of this, reduced to powder, let the patient take two or three scruples at a time, in any convenient vehicle.

An experienced remedy for convulsions, and the falling-sickness in children.

115. Take from one scruple to two, or more, of fine prepared amber, and of native cinnabar ten grains; mix them, and this, sweetned with sugar, let the patient take twice a day, during six weeks, unless he fully recovers before. However, he is to take it for two or three days before each new and full moon, for some months successively.

An often experienced medicine for convulsions, especially in children.

116. Put a pound of the true single piony-roots, scraped and sliced as thin as paper, into three pints of white-wine; infuse them all night on embers, in a pipkin close cover'd; in the morning strain it out hard, and put in a quarter of an ounce of powder'd castor, an ounce of the best spirit of castor, thirty grains of the mofs of a dead man's skull, and thirty grains of the skull it self: put all these into a strong glass, that is very dry, and shake them briskly for half an hour. It may be given in the fit; a spoonfull to a young child; and to a man, or woman, a wine-glass full.

A medicine that has cured very many, especially children, of convulsive fits.

117. Give of the powder of a sound skull of a dead man, as much as will lie upon a groat, made up into a bolus, with conserve of rosemary-flowers, to a child: but in grown persons, the dose must be augmented to double the quantity. The medicine should be given often, if necessity requires. It may, also, be useful to apply to the throat a kind of necklace, made of the roots of vervain, cut into beads.

A plaister to prevent corns.

118. Take yellow bees-wax 4 ounces, verdigrease powder'd and sifted one ounce, the *Caput mortuum* of human skull one dram; incorporate them well, by a little boiling, and make thereof a plaister. Corns

An effectual plaister to soften and loosen corns.

119. Spread a plaister of crude gum ammoniacum, and applying it to the part affected, let it lie on as long as there is occasion.

MEDICINE.

A powerful remedy for corns.

120. Evaporate the strongly exprefs'd juice of radishes, to the consistence of a soft plaister, to be applyed to the part affected, and shifted as often as it grows dry. 'Twill smart for a while, at first, but afterwards 'twill do its work.

A good remedy for corns of the feet.

121. Spread the yeast of beer upon a linen rag, and apply it to the part affected, renewing it once a day.

A try'd medicine to take away corns.

122. The part being made soft by bathing, and scrap'd, apply to the corn a plaister of shoemaker's wax; but if the part be very tender, your plaister may consist of equal parts of shoe-maker's wax, and diapalma, melted together, and spread thin.

An often try'd remedy for corns.

123. Mix up the juice of houseleek, with about equal parts of the thick yeast that sticks to beer-barrels, or to the clay that stops them. Of these make a kind of plaister, which being kept upon the toe for a while, and renewed, will make the corn very soft, and easie to be extirpated.

A try'd remedy for corns.

124. Take strained ammoniacum, and diapalma, of each an ounce, *Arca-num corallinum* half an ounce, white precipitate two drams: mix them well together, and apply the plaister only over the corn, first cut as close as is convenient.

An useful medicine for costiveness.

Costiveness.

125. Take virgin-honey a sufficient quantity, and mix exactly with it as much finely powder'd *Cremor tartari*, as will bring it to the consistence of a soft electuary; of which the patient may take, upon the point of a knife, the bigness of an almond.

An easy medicine for costiveness.

126. Take *Strasburg-turpentine* an ounce, and the yolk of an egg; grind them well together, and put thereto a pint of fat mutton-broth, and exhibit it, blood-warm, for a glyster.

An innocent medicine for costiveness.

127. Boil in as much broth as will fill a large porringer, about half a handful of the leaves of common mallows, chopp'd; and of this broth strained, let the patient make the first part of his meal.

Medicinal Experiments.

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MEDICINE.

For the cramp.

128. Chop the leaves of rosemary very small, and sew them so in fine linen or sarfnet, as to make a kind of garter of them, to be ty'd about the patient's bare leg.

Cramp.

To take off the pain of the cramp.

129. Take of the ointment of populeon two parts, oil of spike one part; mix them, and with the mixture chafe the part affected.

An amulet against the cramp.

130. With the root of mechoacan, in powder, fill a little bag of farlenet, about three inches square; and hang it, by a string, about the patient's neck, so that it may reach to the pit of the stomach, and touch the skin.

For incontinency of urine, or a beginning diabetes.

131. Having cut off the necks of blown sheeps bladders, put the remaining membranes, one over another, into a pot, where being cover'd and dry'd gently in a baker's oven, take them out, pulverize them well, and give as much as will lie upon a six-pence for a dose.

Diabetes.

An useful powder for such as cannot hold their urine.

132. Take roots of the male piony, yellow amber, red coral, and gum arabic, of each a sufficient quantity: reduce them to fine powder, mix them well, and let the patient take of this mixture from ten to twenty grains, twice a day.

A good medicine for the dropsy.

133. An ounce and half of sliced mechoacan, being infused, for 24 hours, in a pint of white-wine, and the liquor drank of every morning for some days, is admirable in the dropsy; and if a little mustard-seed be infused therein, it will be so much the better.

Dropsy.

The Pilulæ Lunares, excellent in the dropsy.

134. Dissolve any quantity of the best thoroughly refined silver, in spirit of nitre, or *Aqua fortis*, first cleansed by silver; then evaporating away the superfluous moisture, let the rest shoot into thin crystals; which being kept in a proper degree of heat, in a sand-furnace, the greatest part of the more loose and fetid spirits of the menstruum, will be driven away; yet the remaining crystals not be brought to flow. Let these crystals be counterpoized with their weight of crystals of nitre, and dissolving each of them apart, in distilled rain-water, afterwards mix the solutions, and abstract the superfluous moisture, till the remain-
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MEDICINE. ing mafs be dry; which you must keep exposed to fuch a temperate heat of sand, that the matter may not melt; yet the adhering corrosive spirits of the menstruum be driven away. To this end the mafs must be stirred, from time to time, till the remaining white powder yields no offensive scent of the spirit of nitre, or *Aqua fortis*. Then, lastly, with the crumb of white bread, made into a stiff paste, form the powder into a mafs for pills, and preserve it in a well stopp'd glass for use. The dose is somewhat uncertain. 'Tis, therefore, adviseable, to make the pills of the size of very small pease; of which, one, given at bed-time, is sufficient in some constitutions, tho' others require two; and there are those who may take three. They ought to be gilt, or otherwise guarded from the tongue and palate, because of their extreamly strong and nauseous bitterness. Where there are ferous humours, one dose of this pill will sometimes work for 3 or 4 days successively, yet moderately, and without much weakning the patient. If a continued use of them brings the patient to a leucophlegmatia, 'tis easily remedied by intermitting them for a while, and giving a little *Crocus Martis*, extract of juniper, or other astringents, to strengthen the *Viscera*, and preserve their tone.

An often try'd medicine for an erysipelas.

Erysipelas.

135. In the blood of a hunted hare, whilst 'tis yet warm, drench clean linen rags; dry them in the free air, and keep them dry: lay a large piece of linen, thus stained, upon the part affected, and either by binding, or otherwise, keep it from falling off, and renew it from day to day, if there be need. If it grow too stiff by long keeping, you may soften it with a little warm water.

An often tried external medicine for an erysipelas.

136. Take the blood of a hare, and if you can have it fresh, anoint the part affected with it; otherwise apply on it a linen rag, that has thoroughly imbibed the fresh blood of that animal, and been dried in the air.

An experienced medicine for an erysipelas.

137. The blood of almost any living creature, is found, by many experiments, to be a specific against an erysipelas, being often rubbed on the affected part; or a cloth dipt in the same being laid moist thereon.

For a slight excoriation.

Excoriations.

138. Melt mutton-suet, taken from about the kidneys, and freed from its superfluous fibres, or strings; and to about two ounces of this, add,
by

by degrees, about sixteen or eighteen drops of oil of turpentine; spread **MEDICINE.** this mixture on a linen-cloth; and by binding, or otherwise, keep it upon the part affected.

For an excoriation, when the true cutis is affected.

139. Take self-heal, and having pounded it very well in a marble, or glass mortar, apply it to the part affected; renewing it but seldom, and not without need.

For an excoriation, and preternatural tenderness of any part of the skin.

140. Spread *Unguentum diapompholigos*, thinly upon lint, to be apply'd to the part affected, and kept on by a bandage, or some sticking plaister.

For a bruise in the eye.

141. Incorporate the crumb of white bread, with black soft soap, into a soft paste; of which make a little cake, and apply it to the bruised part, the eye being first shut, so that it may lie on for some hours. But this ought to be used with caution.

Remedies for disorders in the eyes.

An excellent medicine for clammy humours of the eyes.

142. Let new milk stand till it hath got a little cream upon it; then let the patient, when he is in bed, take up, with his finger, a little of the cream, and shutting his eye-lids, besmear them with it; having a care that very little, or none get into his eyes, because it would make them smart: let the cream lie on till the next morning, and, in case the patient chance to wake in the night, he may, if he finds cause, lay on a little more, and wash all off in the morning.

An often try'd medicine, to take off the pearl on the eye.

143. Take of the juice of celandine, and mix with it about an equal part of pure honey; and of this mixture employ a drop, or two, at a time; letting it fall upon the pearl, morning and evening.

For a blood-shot eye.

144. Take a rotten apple, and as many tops of wormwood as, being well beaten together with it, will make a mass of the consistence of a cataplasm; warm this a little, and put a sufficient quantity of it into a thin and clean linen rag, and let the patient keep it upon the part affected all night; the next morning wash it off with some red rose-water, or the like liquor.

An ophthalmic water to preserve the eyes and sight.

145. Take of the distill'd waters of rue, celandine, and vervain, of each one ounce; mix them, and infuse in them, for ten days, two drams

MEDICINE. drams of *Crocus metallorum*, exquisitely ground, then very carefully filter the infusion; of which let fall into the eye a drop or two, morning and evening; having a care not to shake the glass when you employ the liquor, lest some unheeded dust may have escaped the filter.

For a slight ophthalmia, or blood-shot eye.

146. Shake half a dram of prepared tutty into an ounce of red-rose-water, and drop of it often into the eye.

For an ophthalmia, or blood-shot eye.

147. Take of the juice of housleek two parts, that of daisies and ground-ivy, of each one part; mix these juices together, and to about two spoonsfull of the mixture, put five or six drops of clarified honey: let the juices depurate themselves by residence; and then, in some small silver vessel, clarify them; and of this mixture let fall a drop or two into the eye, three or four times a day.

An experienced eye-water, for an inflammation and tumour of the eye.

148. Take of prepared tutty half an ounce, the water of white roses, and of frogs-spawn, and also of the best canary wine, of each two ounces, of *Aqua mirabilis* half an ounce: mix these well, and drop a very little at a time into the patient's eye.

An experienced water for sharp and slimy humours in the eyes and eye-lids.

149. Take of prepared tutty half an ounce, prepared coral and pearl of each half a scruple, *Trochisci albi Rhafis* five or six grains, red rose-water, and succory-water, of each an ounce and half; mix them well: and if you will have the medicine stronger, you may add three or four grains of aloes to it.

For a light stroke, or bruise on the eye.

150. Take two ounces of betony water, and three drops of clarified honey; mix them well together, and drop them into the eye, three or four times a day. The composition must be made fresh every second or third day.

A powerful medicine for things growing on the eye.

151. Take white paper, and let it flame away upon a clean pewter plate, till there remain so much oil behind, as you think you shall need; blow off the ashes of the paper, and a little spittle being mixt, by the finger, with the oil, make a kind of ointment; which being taken up with a feather, is to be apply'd once or twice a day, as the patient can bear the smart, to the affected eye: and this course is to be continued, till the cure be completed.

For

For hurts that make a solution of continuity in the eye.

152. To two ounces of celandine water, put three or four drops of good clarified honey; and with this dress the eye at least twice a day. But the mixture must be made fresh once in two or three days, or else it will grow sourish.

An often try'd eye-water, especially for outward disorders of the eye.

153. Take of plantain-leaves 4 ounces, of strawberry-leaves as much; bruise and digest these for 24 hours in a pint of good white-wine: then distil them to dryness in a glass-head and body, in *Balneo Maria*. The liquor that is thus obtained, put into a very clean brass vessel, and let it stand there for some hours, till it have acquired a manifest blue tincture; then put to it an equal weight of white rose-water: shake these together, and let fall one drop into the internal corner of the eye; the patient bending backward, and shutting his eye-lids for a minute or two, that the water may disperse on the eye.

An useful medicine for pain or itching in the eye-lids, or in the eyes.

154. Boil half a spoonful of cleansed *French* barley, for a little while, in a pint of spring-water, seasonably putting to it a pugil of dry'd damask rose-leaves. Foment the part, for a pretty while, with a soft sponge dipt in this liquor, morning and night; having a care that it be applied warm, at least.

An excellent eye-water for redness and light films in the eye.

155. Make some lime-water, by pouring a gallon of scalding hot water upon a pound, or somewhat more, of quick-lime; stir them together, and after some hours, decant that which is clear. To a pound of this water, put half an ounce of choice verdigrease pulverized; and, in a very moderate heat, extract a tincture of a fine, light sapphirine colour. Decant this very warily, and let a drop or two of it, at a time, fall into the eye, as often as need requires.

To stop a violent defluxion on the eye.

156. Take red sage and rue, of each one handful, a spoonful of fine wheat-flower, and the white of a new-laid egg, beaten to water; mix these well, and spread them upon very thin leather, or black silk, and apply it to the temples.

For red eyes, from a defluxion of a hot or sharp humour.

157. Take the tops of rosemary one dram, and beat them up with one or two ounces of rotten pearmain, or pippins: and when, by ex-

MEDICINE. quifite beating, you have reduced thefe to a cataplafm, apply it warm to the part affected, binding it thereon, and letting it lie all night.

An eye-water.

158. Beat houfe-fnails in their fhells, and add to them about an equal quantity of juice of celandine; draw off the water in a cold ftill, and keep what will come over, clofe ftopp'd for ufe.

The lady Fitz-Harding's eye-water, which cured a perfon almoft blind, whofe eyes looked like glafs.

159. Take of white rofe-water, and eye-bright-water, of each three fpoonsfull; as much fifted white fugar-candy as will lie on a three-pence, and the fame quantity of fine aloes fifted; fhake all together, and let fall a few drops into the eye, every night, going to bed.

A wrift-plaifter, that often cures flying clouds in the eyes, and fometimes leffer fpecks.

160. Take of rue, camomile, and hemloc, each half a handful; of bay-falt two fpoonsfull, and one or two ounces of leaven; incorporate thefe well together, and apply it to the patient's wrifts, to be kept on till it grow dry,

For hot defluxions on the eyes.

161. Take of prepared tutty half an ounce, white rofe-water, and frogs spawn-water, of each two ounces, *Aqua Mirabilis* half an ounce; mix thefe well together, and let fall two or three drops into the patient's eyes, efpecially at bed-time.

An ufeul eye-water, to keep the eyes cool and moderately dry.

162. Take two ounces of fuccory-water, half a dram of prepared tutty; fhake them well, and keep them together for ufe.

An often try'd wrift-plaifter, for defluxions on the eyes.

163. Take rue, camomile, hemloc, and wormwood, of each half a handful, bay-falt pulveriz'd two fpoonsfull, four dough an ounce; mix all thefe together, moiftning them from time to time with elder-vinegar, to a proper confiftence; and apply it to the wrift of that fide on which the part is affected; renewing it if there be occafion.

For a little tumour in the carneous tunicles of the eyes.

164. Drefs the eye, from time to time, with the decoction of mucilages, to ripen the tumour; then open it with a lancet, and fqueeze out all the matter; and, laftly, cleanse and heal the part with honey. But, when the tumour is beginning, you may, in want of the decoction of

of mucilages, dress the eye with a mixture of equal parts of the waters of melilot, camomile, and betony. MEDICINE.

A plaister to strengthen the eyes, and stop defluxions on them.

165. Take of frankincense two drams, olibanum and mastic, each half a dram; mix these, and reduce them into fine powder, of which a convenient quantity is to be melted and spread upon black ribbon, and applied to the temples.

An often experienced medicine for little strokes, or bruises on the eye.

166. Take betony water three ounces, and five drops of clarified honey; mix them, and drop a little of the mixture, from time to time, into the patient's eye.

An electuary to strengthen the sight.

167. Take conserve of borage and betony, of each an ounce and half, Venice-treacle two drams, Species Dianisi, Diarrhodon Abbatis, Diatrium Santalum, of each half a dram, tartar vitriolate a scruple, Diacorallion a dram and half, oil of fennel seven drops, syrup of violets and of coral, of each a sufficient quantity; mix and make an electuary, to be taken the bigness of a nutmeg twice a day.

For an Ophthalmia Sicca.

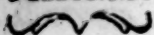
168. Take of the leaves of fennel, hyssop, celandine, betony, and carduus, of each half a handful; of linseed, quince-seeds, fenugreek, and flea-wort seeds, of each half a dram, of French barley one ounce: boil all these a little, in two quarts of fair water, and half a pint of white-wine: and let the patient hold his head (well fitted with a napkin for the purpose) over the fumes, for about a quarter of an hour.

For a film in the eye.

169. Take of roch-alum two parts, turmeric one part, and refined sugar three parts; pulverize each of these separately, then mix them exactly, and warily blow it into the patient's eye, from time to time, as need shall require.

A famous eye-water.

170. Take celandine, the whole plant except the root, and having shred it a little, put it into a retort, and distil it in balneo. When all the liquor is come over, empty the vessel, and put it back upon as much more of the fresh plant, and distil a liquor, to be poured once more upon fresh celandine as before; and keep this last water close stoppt. 'Tis to be outwardly us'd, by three or four drops at a time.



A medicine for hurts in the eye.

171. Take succory-water, and crumbs of white-bread, enough to bring it to a due consistence; then add a little saffron; sometimes, also, you may put to it a little honey, to make it more cleansing and healing. Apply it, with pledgets of flax, to the part affected.

A good water for eyes that are foul, and pained by sharp humours.

172. Take prepared pearl, and coral, of each one scruple, aloes callina, finely powder'd, three grains, red rose-water, and succory-water, of each one ounce; mix them well; and if you would have the mixture stronger, put in a few grains of *Trochisci albi Rhafis* in very fine powder.

An experienced medicine for strengthening a weak sight.

173. Take of eye-bright, sweet fennel-seeds, and fine sugar, all reduced to powder, of each an ounce, nutmeg, also pulveriz'd, one dram; mix these very well together, and take of the composition, from one dram, to two or more, from time to time.

To take off little pimples, or inequalities, within the eye-lids.

174. Take eye-bright-water, plantain-water, of each a spoonfull, and half a spoonfull of red rose-water; mix these, and put to them about 15 grains of prepared tutty; shake them together, and let the powder fall to the bottom; and, with the clear liquor, moisten the eye several times in a day.

To strengthen a weak sight.

175. Take eye-bright, penny-royal, rue, celandine, lovage, faxifrage, of each half a handful, blue-bottle flowers, fennel-seeds, parsley-seeds, of each half a dram, grains of paradise one dram, hyssop, organy, willow-leaves, each half an ounce, galingal three drams, ginger half a dram, cinnamon one dram, sugar half an ounce. Let them be finely powder'd, and very well mixt together. Take of this powder one scruple, or half a dram, every day with your dinner.

To strengthen the sight.

176. Take rosemary-flowers, sage, betony, rue, and succory, of each one handful; infuse these in two quarts of good sack, and distil them in a copper alembic. The dose is a moderate spoonfull.

To strengthen the sight.

177. Take powder of eye-bright one ounce, ordinary fennel-seed, in powder, half an ounce, powder of nutmeg half a quarter of an ounce, double refined sugar two ounces. All these, being finely powder'd, are

are to be mixt together, and taken as much as will lie on a shilling at a time, as often as you please. The powder is to be kept in a box, close shut, in some dry place. This has perform'd great cures in dimness of sight, and rheums in the eyes. MEDICINE.

A medicine several times used, for a light stroke, or contusion of the eye.

178. Put to two ounces of carduus-water, or that of betony, three or four drops of honey; use it every three hours. But keep it not above a day or two, lest it grow sour.

A drink, to be taken like tea, for strengthening the sight.

179. To a quart of water ready to boil, put half a handful of eye-bright; and let the liquor boil a very little before you take it off.

A water to strengthen the sight.

180. Distil clary in a cold still; and of the water let the patient take every morning, and, if need be, every night, going to bed, from two or three spoonsfull to six, either alone, or sweetned with a little sugar; let him, also, with the same water, unsweeten'd, bathe or wash the parts affected, in the morning, and at bed-time, or oftener.

An excellent water to preserve the sight.

181. To half an ounce of celandine-water, and two drams of succory-water, put two or three drops of clarified honey, and shake them together when you use them. Of this water let fall a drop or two into the eye, once or twice a day. It will not keep above three or four days, especially in summer, and, therefore, must be often renewed.

An often experienced medicine for blood-shot eyes.

182. Cut a new laid egg, boil'd hard, into halves, and apply one of these, considerably warm, to the part affected, and keep it on for some hours. To the same purpose you may apply a poultis made of a rotten apple; the cold being first quite taken off.

A medicine for blood-shot, or inflamed eyes.

183. Bathe the eyes several times every day, with a wash made of frogs-spawn-water a pint, and salt of tartar a dram.

An excellent remedy for an inflammation in the eyes.

184. From an apple, cut into halves, take out all the core, fill up the cavities with the tender tops of common wormwood, tie the halves together, and roast the apple well: then beat it, with the herb, to a kind of poultis, apply it warm to the part affected, and bind it thereon; letting it lie all night, or, if you use it in the day-time, for 6 or 8 hours.

An useful remedy for redness of the eyes.

185. Take a blanch'd almond, and three grains of camphire, and in a marble mortar, incorporate them by grinding; then add, little by little, two or three ounces of red rose water; still grinding them till the whole be brought to a kind of emulsion. Drop a little of this into the part affected.

A medicine for redness of the eyes.

186. If the redness be attended with a fiery hot rheum, wash the eyes, twice or thrice a day, with brandy.

For a slight inflammation of the eyes, or a hordeum growing on the eye-lid.

187. Take fresh housleek; beat it to a kind of cataplasm, and lay as much as is needful of it in the fold of a linen-rag, to be so apply'd, that the cataplasm may reach the eye, and the rest of the cloth be fasten'd about the patient's head. Let the medicine lie on all night, and be taken off the next morning. Repeat this application two or three times occasionally.

For a slight redness of the eyes.

188. Take of French barley half an ounce, and of damask roses half a handful; boil them, a very little, in a pint of spring-water; and with this moisten the part affected.

For a slight redness of the eyes.

189. Take frog-spawn-water a pint, common spirit of wine 4 ounces; mix them: wash the eyes therewith, five or six times a day; and at bed-time apply over them a cataplasm of a rotten apple.

An useful medicine to prevent dryness, and some other disorders of the eyes.

190. Take of choice virgin-honey two spoonsfull, of succory-water, and the distilled water of eye-bright, each 4 spoonsfull; mix them, and in a very clean vessel, over a very gentle fire, let them evaporate, taking the scum off from time to time, till the mixture comes to the consistence of a syrup; keep this in a glass well stopp'd, and use it by letting fall a drop or two, at a time, into the eye.

A medicine to prevent running of the eyes.

191. In half a pint of white-wine, dissolve two drams of white vitriol; filter it, and add choice honey two ounces: with this bathe the eyes two or three times a day.

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MEDICINE.

The vitriolate eye-water.

192. Put 4 grains of Roman vitriol, to 4 ounces of the distilled water, either of roses, succory, fennel, &c.

For a light stroke, or bruise on the eye.

193. Into half an ounce of celandine water, shake three or four drops of clarified honey; and let fall of this into the eye a drop or two, twice or thrice a day.

For a stroke, or bruise in the eye.

194. Take of betony water, and hyssop water, of each one ounce; herein stir some blades of saffron, till the liquor be pretty well colour'd; and lastly, add to it 4 or 5 drops of clarified honey.

For a stroke, or bruise on the eye.

195. Take celandine water three ounces, spirit of saffron one ounce; mix them, and wash the eyes therewith several times a day; and if they be very sore, red, or blood-shot, after washing anoint them every time with a little pure virgin-honey.

To take off films, or the like, from the eyes.

196. Take choice bole-armeniack, in very fine powder; and blow it gently into the eye, once or twice a day. But if the patient be subject to swelling, heat, or disaffection in the eye-lids, incorporate the powder with a little clarified honey.

To take off films from the eyes.

197. Take prepared coral one ounce, of pearls three drams, crabs-eyes one dram, virgin-honey two ounces; mix them, and anoint the eyes therewith 4 or 5 times a day, but chiefly morning and evening.

To strengthen weak eyes subject to rheums.

198. Take *Lapis Calaminaris* four ounces, rose-water a pint; shake them well together: then let it settle; pour off the clear water into a vial, and drop of it into weak eyes two or three times a day.

An experienced remedy for sharp and hot humours in the eyes.

199. Into a quart of new milk, as it is boiling, put about two handsfull of green housleek, fresh gather'd, and chopt small, and let the milk boil on, till it will yield no more curd: then strain the green posset-drink, and let the patient take once or twice, every day, a pint, sweetned with fine sugar. The drink may best be taken cold.

MEDICINE.

An excellent fumigation for pains in the eyes, too great dryness of them, and when a beginning cataract is apprehended

200. Take of fennel, hyssop, betony, celandine, carduus, of each half a handful, linseed, quince-seed, fenugreek, and fleawort-seed, of each half a dram, of French barley one ounce: boil these in two quarts of fair water, and half a pint of white-wine; and let the patient hold his head over the fumes of them, taken off the fire, for about a quarter of an hour every morning.

For sore eyes.

201. Take the crumb of white-bread, half an ounce, coral, pearl and tutty prepar'd, and white sugar-candy, of each half a dram; powder of red-roses a dram and half, flowers of St. John's-wort one dram; and with a sufficient quantity of milk, make a cataplasm, to be spread upon linen, and bound over the eye.

For heaviness, and pain in the eyes.

202. Take flowers of melilot, elder, and of marigolds, of each a small handful, linseed, seeds of fenugreek, fleawort, cummin, and quinces, of each half a scruple, French barley half an ounce, damask roses half an ounce, spring-water a pint and an half; mix and make a decoction, with which foment the forehead, temples, and eye-brows, warm.

For a dry inflammation in the eyes.

203. Take of betony, hyssop, rue, wormwood, vervain, sage-flowers, and rosemary-flowers, of each half a handful; the seeds of cummin, fennel, and carduus, of each a quarter of an ounce; boil these, a little, in two or three quarts of fair water, and let the patient hold his head, for about a quarter of an hour, over the steam of the decoction; using a napkin to keep the smoak from dissipating, and to direct it to his eyes.

A famous eye-water.

204. Take two or three ounces of the water of pimpernel, distill'd in balneo, put this into a little porringer of rose-copper; and add about the bigness of a filbert, of strong quicklime: cover the vessel, and let the ingredients lie in it till the liquor hath acquir'd a bluish colour. Then very warily pour off the clear, and add to it as much live honey, as will give it a little taste: use it after the usual manner of such waters; and if it be too strong, dilute it a little with water of the same plant, or good spring-water.

A famous eye-water.

205. Take red rose-water a quart, aloes in fine powder, half an ounce, white vitriol, *Vitrum Antimonii*, *Crocus metallorum*, of each six drams; mix and digest, warm, for a month: then use the clear liquor 3 or 4 times a day: it has scarcely an equal.

An eye-water.

206. Take red rose-water, plantain-water, of each an ounce; tutty prepared, half a scruple; *Lapis Lazuli* prepared, 6 grains; red coral prepared, 5 grains; mix, and make an eye-water. This dropped into the eyes, being first well shaken, cures inflammations of them, provided there be no great foulness, or scrophulous disposition in the patient. It takes off the redness of the eye-lids, if with a sponge dipt in it, they be often wetted: it also takes off films very well.

To clear the eyes from films.

207. Take human dung, of a good colour and consistence, dry it slowly till it be pulverable; then reduce it into an impalpable powder, which is to be blown once, twice, or thrice a day, as occasion shall require, into the patient's eyes.

To allay heat in the eyes, proceeding from sharp humours.

208. Beat the white of an egg into a water, in which dissolve a considerable quantity of refined loaf-sugar; and then drop some of it into the patient's eyes.

For a slight stroke, or bruise on the eye.

209. Take two spoonsfull of fennel-water, or of betony-water, and let fall into it 4 or 5 drops at most, of good clarify'd honey: shake them well together, and use them twice or thrice a day. But you must have a care to make this mixture fresh once in 4 or 5 days, especially in summer: for if it be much longer kept, 'twill grow sour.

An excellent eye-water, to preserve them from rheums, especially sharp ones.

210. From two parts of celandine, and one of eye-bright, distil in *balneo* a water, which put upon pulveriz'd *Lapis Calaminaris*, and let them digest together, in an exactly clos'd vessel, for some weeks; adding, before you use it, a third part of brandy.

For the falling-sickness in children.

211. Give half a dram of choice amber, finely powder'd, for six or seven weeks together, once a day, when the stomach is empty, in about 4 ounces of good white-wine.

For the falling sickness.

*Medicinal Experiments.**Against the falling-sickness.*

212. Take of the powder of true miffeltoe of the oak, as much as will lye upon a six-pence, early in the morning, in black-cherry-water, for some days, near the full moon.

*To appease the heat of fevers by an external remedy.**Fevers.*

213. Apply to the soles of the feet a mixture, or thin cataplasm, made of Virginia tobacco, beaten up with as many fresh currants, as will bring it to a poultis.

An excellent drink in fevers, tho' malignant.

214. To a quart of boiling spring-water, put one ounce of hartshorn calcin'd to perfect whiteness; and when the mixture is cold, add three ounces of syrup of the juice of lemons: when you wou'd use it, shake it well, and let the patient take a moderate draught, several times in the day and night.

A useful drink in feverish distempers.

215. In a pint and half of clear posset-drink, boil about one ounce of the cleans'd roots of dandelion, sliced small, till near half a pint be wasted; then strain it, and let the patient take half a pint, or the whole quantity, if he can, at a time.

A good drink in continual fevers.

216. Boil the leaves of rue in fair water, till the liquor taste pretty strong of the plant: this being strained, is to be made palatable with liquorice, or a little sugar; and to half a pint of it, add about ten drops of spirit of vitriol; and let the patient use it for ordinary drink.

A good drink to be frequently used in fevers, especially continual ones.

217. Give in half a pint of some small convenient drink, half an ounce of hartshorn, burnt to a great whiteness, and a little boiled in the liquor; and this is to be taken from time to time.

Sir Walter Raleigh's cordial; an approved and most excellent remedy for fevers, fluxes, or any case where diaphoretics, antidotes, and cordials, are proper.

218. Take the dry'd flowers of borage, rosemary, marigolds, red july-flowers, *Rosa solis*, and elder-flowers, of each two quarts, of dry'd scor-

scordium, carduus, angelica, baulm, mint, marjoram, setwall, betony, of each MEDICINE. 4 handfuls; the barks of sassafras, and lignum aloes, of each four ounces, in powder; of kermes, cubebs, cardamoms, and zedoary, of each an ounce; saffron half an ounce, juniper-berries, tormentil roots, round birthwort roots, of each an ounce, and gentian root half an ounce. Draw the tincture of all these with spirit of wine *in balneo*, and afterwards calcine the ingredients, and put the fix'd salt they afford to the tincture. To fix ounces of the extract of all these, with their salt, put three ounces of the magistery of coral, *Terra sigillata* four ounces, prepared pearl two ounces, bezoar-stone three drams, calcined hartshorn four ounces, ambergrease four drams, musk thirty grains, powder'd sugar-candy one pound and a half, wherewith the perfumes being ground, add the dry ingredients thereto, and reduce them to a fine powder; then grind the tincture and dry things together, adding syrup of lemmons, and of red roses, equal parts occasionally.

To make the magistery of coral for this cordial, put eight ounces of whole coral, into an open calcining pot, and let it stand for 24 hours, in a calcining furnace, till the coral be white as snow; then put it into three quarts of distilled vinegar, in a bolt-head; into the neck whereof invert another, and set them in a sand-furnace, up to the vinegar. Let it boil, without intermission, for 24 hours, by which time the vinegar will become red; and, when cold, pour it off into a bell-glass; exhale away the moisture *in balneo*, and reserve the coral, perfectly dry, for use.

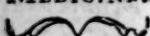
The dose for a man is about the bigness of a small hazel nut; if by way of prevention, the magnitude of an ordinary pea may suffice; but in urgent cases the dose may be increased to the quantity of a nutmeg.

A water for a fistula, all manner of wounds, swellings, old ulcers, cankers, tetters, boils, scabbs, or green wounds.

Fistula's.

219. Take of bole-armeniatic, and white vitriol, each 4 ounces; of camphire one ounce; boil the two latter together in an earthen vessel; till they become thin, and stir them till they afterwards grow hard in cooling; then powder them in a mortar, and mix them with the bole-armeniatic in powder, and keep the whole in a bladder for use. Into two quarts of boiling water, taken off the fire, put three large spoonsfull of this powder; and afterwards put them up into a glass, and shake it twice a day: but before 'tis used, let it be well settled, and very clear. Dip a soft, pliable tent herein, and apply it as hot as the patient can bear it, laying a clean linen cloth over the dressing four double, first moisten'd in this water, and bind it on with a roller: continue to do thus every morning and evening. The water may be put into an oyster-shell, when the sore is dress'd, for pewter will suck it up.

MEDICINE.



Furor uterinus.

To appease the fits of a Furor Uterinus.

220. Burn the feathers of partridges, for a competent time, under the patient's nose.

A try'd medicine for the falling down of the fundament.

Falling of the fundament.

221. Put some sliced ginger in a little pan, heat it by clear and well-kindled coals, and let the patient receive the fume of it, cast on by degrees, in a proper seat, where the lower part of the body may be well cover'd, for about half a quarter of an hour at a time.

For a slight gangrene.

Gangrene.

222. After having lightly scarified the part, apply, as hot as the patient can well bear it, a cataplasm made of strong brandy, and the crumb of white-bread; shifting it 3 or 4 times a day, or oftener, if need be.

To prevent a gangrene upon a great pain, and to strengthen the part.

223. Take of melilot-plaister, and diapalma, equal parts; and having melted, and well incorporated them together, make thereof a thin plaister, which, being prickt full of holes, is to be laid upon the inflamed, or bruised part, first lightly scarify'd.

An experienced medicine for a gonorrhœa.

Gonorrhœa.

224. Infuse two ounces of ripe laurel-berries, for a day, in a quart of good white-wine; and of this let the patient drink about two or three spoonsfull, twice a day, for a pretty while together; omitting it once in three days, that he may take some gentle purging medicine.

For a gonorrhœa.

225. Swallow about half a dram of choice mastic, in powder, put into the yolk of a new laid egg; washing it down, if it be thought needful, with any convenient liquor.

For the gonorrhœa.

226. Take equal parts of choice amber, and of mastic, both in fine powder, mix them, and of this mixture give half a dram at a time in a proper vehicle, or in a draught of chocolate: continue it for three weeks, or a month, if need require; purging the day before you begin to take it, and once every week afterwards, especially when you leave off the use of the powder.

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For a gonorrhœa.

227. Take equal parts of choice red coral, and of mastic, reduce them separately to fine powder; mix them very well, and give about 30 or 40 grains for one dose.

An often experienced remedy to expel gravel, and provoke supprest urine.

228. Take the thick membrane that lines the gizzard of a cock or hen, and having wip'd it clean, dry it so, that it may be beaten to powder: with this mix an equal part of choice red coral calcin'd, and of the mixture give from 20 or 30, to 40 or 50 grains. *The gravel.*

An experienced remedy to expel gravel, and provoke urine.

229. Take the juice of onions two spoonsfull, white-wine half a pint; mix them for a draught. It gives present ease; and, if repeated for some time, soon cures.

To drive away gravel and small stones.

230. Take the thick skin, found in the gizzard of a cock or hen, and having warily dried it, till it be pulverable; give from a scruple to two scruples of it, in a draught of any convenient vehicle.

To take off the pains of the gout.

231. Take red-lead, ground fine, half a pound, oil of earth-worms one pound; boil them to the consistence of a hard plaister, without burning: afterwards add of camphire two ounces, dissolved in oil of earth-worms, and make a plaister of a just consistence. *The gout.*

An excellent ointment in the gout.

232. Take Barbadoes-tar, and palm-oil, of each a like quantity, melt them gently together; and with the mixture warm, let the part be anointed, and warily chafed.

An effectual medicine for gouty pains.

233. Beat linseed, with a little water, in a marble mortar; rubbing it very well, that the medullary part being separated from the husk, may make the water considerably white. In this liquor, clean rags being thoroughly wetted, apply them, somewhat warm, to the part affected, shifting them, if need be, once in an hour or two.

A speedy remedy to take off gouty pains.

234. With a feather, dipt in good spirit of sal-armoniac, moisten, gently, all the parts affected.

A medicine that soon appeases the pains of the gout.

235. Take of black soap 4 ounces, choice wood-loot, finely sifted a dram and half, and half the yolk of an egg: incorporate them together, and, spreading the mixture somewhat thin, apply it warm, by way of cataplasm, to the part affected.

An often try'd medicine to appease the pains of scorbutic running gout.

236. Having fill'd an earthen pot with cleans'd earth-worms, and luted on a cover, set it into an oven, with a batch of bread, and let it stand there till the oven be cold. Then take out the pot, and having remov'd the cover, you will find the matter turn'd into a gross ill-scented liquor. Strain this by expression, and keep it stop'd, to rub therewith the part affected, with a warm hand, once or twice a day. If the smell be offensive, you may put to it a few drops of oil of rhodium, &c. to correct it.

To take away gouty, or other arthritic pains.

237. Anoint the part with highly rectify'd spirit of human urine, the cold being just taken off, once or twice the first day, and no longer, unless the pain continue.

To check the fits of the gout, and, in some measure, to prevent them.

238. Take three ounces of sarsaparilla sliced thin; and an equal weight of raisins of the sun, rubb'd very clean, but not broken; put both into three quarts of spring-water, and let the containing vessel stand in a moderate heat, that the liquor may simmer for several hours, yet without bursting the raisins; keep this decoction well stop'd, and let the patient use it for his only drink.

To appease the pains of the gout, and lessen the fits of it.

239. Take one part of spirit of sal-armoniac, and three parts of spirit of wine, neither of them too well rectify'd: shake them together; and having dipt old, clean linen rags in the mixture, apply them to the part affected, shifting them now and then.

A poultis to appease pains and aches, even such as are arthritic, or gouty.

240. Boil or stew onions in water, till they be soft enough to make a poultis; then drain away the water, and beat them; and having spread them, to a considerable thickness, upon a linen-cloth, apply them as hot as the patient can well bear, and let them be kept on all night.

To give ease in the fits of the gout.

241. Take three parts of oil of turpentine, and one of chymical oil of spike; shake them well together, and with this mixture anoint the parts lightly.

Cinnamon-drink, good in gripes and fluxes.

242. Boil two ounces of powder'd, calcin'd hartshorn, in three pints of spring-water, till a pint be wasted; then take it off the fire, and infuse in it an ounce and half of good cinnamon; setting it upon embers, in a close vessel, for about an hour. Sweeten it with sugar, and drink about a quarter of a pint at a time. Gripes.

An excellent remedy for gripes and fluxes.

243. Of the tincture of corn-poppy-flowers, made with common spirit of wine, give from one to two spoonsfull, mix'd with a few drops of laudanum, and 4 ounces of black-cherry-water.

For fluxes, especially accompanied with gripings.

244. Take of crude *Lapis Calaminaris*, finely powder'd, two scruples, of white chalk one scruple; mix them exactly, and give them in a spoonfull or two of new milk, twice, or, if the case be urgent, thrice a day.

An often try'd medicine for the griping of the guts.

245. Into a quarter of a pint of brandy, put a toast of bread whilst very hot; and as soon as it is thoroughly drenched, let the patient take it out, and eat it hot: and this may be repeated, if there be need, two or three times a day.

An often try'd remedy for the gripes in young children.

246. Take of oil of nutmegs, and of wormwood, of each a like quantity; mix them well, and with the mixture a little warm'd, anoint the patient's navel, and the pit of the stomach.

To correct the laxity of the gums, and fasten the teeth.

247. To a pint of claret-wine, put a dram of myrrh, and two drams of Japan earth, and having dissolv'd as much of it as you can, pour off the clear, and let the patient wash his mouth therewith from time to time. For disorders in the gums.

To strengthen the gums, and make the teeth grow fine.

248. Take *Catechu*, or Japan earth, and dissolve as much as you can of it in a pint of claret, or red wine; then decant the liquor warily, and let the patient, now and then, wash his mouth with it, especially at bedtime. To

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To evacuate the rheum that swells the gums, and causes the tooth-ach.

249. Dissolve a spoonfull of good mustard in a pint of French wine, and having warm'd it a little, let the patient, from time to time, wash his mouth with it, and hold it therein for a pretty while together.

An approved medicine for scorbutic gums, and to fasten the teeth.

250. Take of white-wine a pint, of alum half an ounce, of juniper berries, and of red sage, each one ounce; boil these together, till a quarter of the liquor be wasted; then put into the remaining part 4 ounces of honey, and let it boil till the scum be all risen; filter it, and put into it one dram of *Balsamum vitæ*.

A medicine for scorbutic gums, and to fasten the teeth.

251. Take claret-wine a pint, roch-alum half an ounce; mix, dissolve, and add six ounces of strong tincture of Japan earth, made with common brandy.

To take out the marks of gunpowder, shot into the skin.

Gun-powder
marks.

252. Take fresh cow-dung, and having warm'd it a little, apply it as a poultis, to the part affected; renewing it from time to time, as occasion shall require.

An excellent styptic powder to stop hemorrhages.

Hemorrhages.

253. Take equal parts of white sugar-candy, roch-alum burnt, and white vitriol, pulverize them exceeding well, and mix them diligently; and having dipt pledgets of lint, moistned with the white of an egg, into this powder, apply them to the orifices of the bleeding vessels. And after the dry ingredients are mixt, you may grind them with as much whites of eggs, beaten to water, as will make a paste, to be thoroughly dry'd in the air, and then again reduc'd to powder.

A powerful styptic.

254. Make a fine powder of *Lapis Hamarites*, by grinding it exactly well with an equal or double weight of sal-armoniac; and of this high-coloured sublimate, put a little upon the orifices of the bleeding vessels.

A medicine for stanching of blood.

255. For stanching of blood, few medicines exceed the colcothar of vitriol, whether wash'd and freed from its salt, or unwash'd.

To

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MEDICINE.

To stanch blood, especially in wounds.

256. Take puff-balls, when they are full ripe, which is in autumn, and breaking them warily, save the powder that will fly up, and the rest that remains in their cavities; and strew this all over the part affected, binding it on; or proceeding further, if need be, according to art.

To stanch blood from the nose.

257. Let the patient hold knot-grass, and Solomon's-seal, in his hand, till it grow warm there, or longer, if need be.

To stanch blood in any part of the body.

258. Take plantain-water two ounces, barley-cinnamon-water six drams, spirit of vinegar one ounce, dragons-blood half a dram, syrup of myrtles five drams; mix and make a julep, of which let the patient take three spoonsfull every hour.

A styptic water, for stopping of blood in any part of the body.

259. Put one pound of excellent quick-lime into a clean earthen pot, pour upon it five or six pounds of fountain-water, cover the pot close, and let it lie to infuse for about an hour; then stir it with a stick for a little time, and let it lie, as before, for 24 hours, sometimes stirring it; lastly, let it settle; and the water being very clear above, pour it off by inclination without stirring: take of this water one pound, which being put into a vial, add to it a dram and half of sublimate, finely powdered; then shake all together, so that the powder may dissolve, and be of an orange colour, and the liquor, in the end, clear and limpid; the red powder falling to the bottom. The water being clarified, you must pour it from the grounds into another vessel; and add to it one dram of oil of vitriol, and an ounce of *Saccharum Saturni*. Shake all together, that they may mix the better; afterwards let all settle, and pour off the clear water for use.

An excellent styptic for stopping of blood.

260. Take *Hungarian* vitriol, and alum, of each half a pound, phlegm of vitriol ten pounds; boil to a dissolution of the vitriol and alum: being cold, filter it through brown paper; and if any crystals shoot, separate the liquor from them, adding to each pound one ounce of oil of vitriol. Dip cloths into this liquor, and apply them to the part affected.

An often try'd styptic to stanch blood, especially in wounds.

261. Take colcothar, as it comes out of the retort, and having powdered it, roll tents of lint in it, and apply them to the orifices of the

MEDICINE, greater vessels; and fill the cavity of the wound, partly with colco-
 ~~~~~ thar too.

*An effectual medicine to stop bleeding in wounds, and check some other hemorrhages.*

262. Strew upon the part the fine powder of clear rosin.

*A quick remedy for a small fresh cut or wound.*

263. Let the patient speedily plunge the hurt part into brandy, and keep it there for a while, till the pain thereby excited, cease, or be much abated: or if the part be unfit for this operation, the liquor may be apply'd to it, immediately, with a sponge, &c.

*For the head-ach.*

Head-ach.

264. Take green hemloc that is tender, and put it in your socks, so that it may lie thin between them and the soles of your feet: shift the herb once a day.

*An excellent medicine for fits of the head-ach.*

265. Boil a handful of fresh rosemary, for a pretty while, in a quart of common water; and let the patient cover his head and face with a napkin, so that he may receive the steam of the decoction for some time, as hot as he can well bear it.

*An experienced sternutatory to clear the head.*

266. Let the patient snuff up, in the morning fasting, a small spoonfull, or less, of the clarified juice of ground-ivy, or of beets; spitting out, from time to time, what liquor comes into his mouth.

*An excellent cephalic, good also for the eyes.*

267. Take the flowers of betony, marjoram, damask-roses, sage, and rosemary, all at discretion: to these add the powder of *Lignum aloes*, and some seeds of *Nigella Romana*. Reduce all to powder, to be used as a hair-powder, when the patient goes to bed.

*An experienced medicine for dulness of hearing, and hysterical disorders.*

Hearing: dis-  
 order'd.

268. The juice of red onions is excellent for diseases of the ears, or for deafness, in the beginning. And betony roots wonderfully prevail against all disorders of the womb.

*An approved remedy for deafness.*

269. Of the breast milk of a woman, let fall three or four drops warm, as it comes from the nipple, into the part affected.

For

*For difficulty of hearing, from a cold cause.*

270. Out of a root of garlic, choose a chive of a convenient bigness; and having passed a piece of thread through one end of it, that thereby it may be pull'd out at pleasure, crush it a little between the fingers, and anoint it all over with oil of bitter almonds; put it into the cavity of the patient's ear at bed-time, and draw it out the next morning, stopping the ear afterwards with black wool: and, if need require, this is to be repeated with fresh garlic for some days successively.

*For the heart-burn.*

271. Take from 15 or 20, to 30 or 40 grains of crabs-eyes, reduced to very fine powder, either alone, or in any convenient conserve or syrup. *Heart-burn.* 'Tis, for the most part, best to take this medicine, when the stomach is empty.

*For a hoarseness upon a cold.*

272. Take three ounces of hyssop-water, sweeten it with sugar-candy; *Hoarseness.* then beat well into it the yolk of an egg, and drink it at a draught.

*For hysterical affections, and several distempers of the nerves.*

273. Upon one ounce of volatile salt of hartshorn, drop as much *Hysterical disorders.* spirit of nitre as will satiate it, when the conflict is quite ceased. Digest the mixture for a while, that it may acquire a red colour; keep it carefully stop'd, and give 4 or 5 drops, twice a day, in any convenient vehicle.

*For the vapours, or fits of the mother.*

274. Dissolve a large quantity of sea-salt in the best wine-vinegar; and in this dip a soft linen cloth, which, being folded so as to make three or four doubles, is to be applied warm to the soles of the patient's feet, and kept on till the fit be over.

*For the yellow-jaundice.*

275. Take an ounce of Castile soap, slice it thin, put it into a pint of *The jaundice:* cold small beer, set it on the fire, let it boil, gently, half away; after it has boiled for some time, scum it once; strain it through a sieve, warm it, and drink it all in a morning fasting; take a small lump of sugar after it, and fast for two or three hours. The patient may walk about, and eat his accustom'd meals. If at any time he drinks wine, let it be white-wine. If he be far gone in the distemper; two or three days after he may take it once or twice more, and no oftener. Refrain all other medicines: this will keep for a week or longer.

*For the jaundice.*

276. Take two or three ounces of hemp-seed, and boil them till some of them begin to burst, and a little longer, in a sufficient quantity of new milk, to make one good draught; which the patient is to take warm, repeating it, if need be, for some days together.

*For the jaundice in children.*

277. Take half an ounce of choice rhubarb in powder, incorporate with it exactly, by long beating, two handfuls of well cleansed currants. Of this electuary let the patient take, every morning, about the quantity of a nutmeg, for several days together.

*An experienced cure for the yellow-jaundice.*

278. Take the gall-bladder of a sheep, and near the top, without emptying the liquor, make a small hole, at which put in two or three drops of the patient's urine; then tie up the upper part of the bladder, and hang it in the free air till it dry up.

*An effectual medicine for the yellow-jaundice.*

279. Give about half a dram of white hens-dung, dry'd, and mixt with a little sugar, in a few spoonsfull of white-wine.

*A medicine almost specific for the yellow-jaundice.*

280. With clean filings of steel mix some loaf-sugar; grind them long with great exactness; for in that consists the chief secret of this medicine. Of this impalpable powder, give about half a dram for a dose, besides the sugar, twice or thrice a day, in any convenient vehicle.

*A specific for the yellow-jaundice.*

281. Take one part of good saffron, gently dry'd and powder'd, and incorporate it well with four parts of choice turmeric. Take, also, a handful of fresh sheeps-dung, and let it steep in about a quart of strong ale, in a moderate heat, till the liquor be fully impregnated with the dung; then strain it lightly through a linen-cloth. In a large draught of it, give about half a dram of the forementioned powder. This do in the morning fasting, and in the evening about bed-time; giving also another dose on the following morning.

*For the yellow-jaundice.*

282. Take rhubarb two drams, saffron, and mace, of each a dram, hemp-seed one handful; bruise them, and put thereto a quart of white-wine, and set all in a gentle heat to extract: then take, mornings and evenings, on an empty stomach, about a quarter of a pint; and, when



## Medicinal Experiments.

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when all is spent, pour more wine upon the ingredients, adding a little MEDICINE: fresh rhubarb and saffron, and use it as before.

*A medicine, almost specific, for the jaundice.*

283. With small ale, draw a deep green tincture from fresh sheep's-dung; and in a little draught of this, give from half a dram to a dram of a powder'd mixture, consisting of 4 parts of turmeric, and one of *English* saffron. This dose may be given twice, or thrice a day; the patient, whom it will dispose to sweat, keeping very warm, whilst the operation lasts.

*For the black jaundice.*

284. Boil a spoonfull of honey, gently, and scum it, till it come to a good consistence; then add of wheat-flour and saffron, reduced to a powder, as much of each, as will lie upon the point of a knife; and having mixed all well, put it over the coals again, till it lose its smell; afterwards keep it in a little earthen pot, and let the patient, with the quantity of a pea, anoint the navel, and fill the cavity thereof with it; repeating the application for some days together, when the stomach is empty, and abstaining from meat and drink for about two hours after the medicine is used.

*To take off the pain and inflammation of ulcers in the legs, and elsewhere.*

285. In a quart of water, boil about as much white-bread, as is usually contained in a half-penny loaf; then add to it two ounces of good sheep-suet cut small; and when that is boil'd a little, add one ounce of powder'd rosin, and a little well-sears'd brimstone: of these make a cataplasm, which is to be kept, constantly, on the part affected, and shifted once or twice a day, as need shall require.

*To make an issue raw, that begins to heal.*

286. Take of *Lapis infernalis* one ounce, of crown soap an ounce and an half, chalk finely powder'd six drams; mix them together carefully, and keep them close stop'd, except when you mean to use them.

*An internal medicine for the itch.*

287. Boil four ounces of clean quick-silver, in a gallon and half of spring-water; and let the patient take of this between a quarter and half a pint at a time, after purging.

*An experienced wash, that quickly cures the itch.*

288. Take strong quick-lime one pound, and put to it a gallon of spring-water; let them lie together for some hours, and then warily pour off the clear; filter the rest, and take two ounces of quick-silver, tyed up in a linen bag; hang it in the liquor, and boil it for half an hour;

MEDICINE. hour; then pour off the clear liquor once more, and wash only the hands with it, twice, or, at most, thrice a day.

*An experienced liquor to cure the itch in the hands or face, without mercury or sulphur.*

289. Take a handfull of the roots of elecampane, and as much of sharp-pointed dock; shred them small, and boil them in two quarts of spring-water, to the consumption of a pint. Then strain the liquor, and with it let the patient wash his hands, or other parts affected, once or twice a day.

*To mitigate pains in the kidneys.*

*For disorders in the kidneys.* 290. Take oil of scorpions, and oil of bees-wax, of each a like quantity; mix them well, and with it, moderately warm'd, anoint the pained kidney.

*An effectual remedy for a stoppage in the kidneys.*

291. Give, in any convenient liquor, about twelve grains of salt of amber for a dose.

*A medicine, almost specific, for exulcerations in the kidneys.*

292. Having reduced jet to fine powder, give of it about half a dram for a dose, in white-wine, in the morning fasting, and at bed-time, for some days together.

*The great medicine of a famous empiric, for the king's-evil.*

*King's-evil.* 293. Give, for a good while together, a pretty strong decoction of devil's-bit.

*An useful drink for the king's-evil, and some disorders from the like cause.*

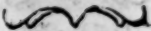
294. Take a large handfull of the leaves of ground-ivy, wash off the dust with beer, and put the herb into a gallon of ale-wort; when 'tis ripe for drinking, draw it out into bottles, and let the patient take a draught of it twice or thrice a day, at meals.

*An useful drink for the king's-evil.*

295. Take white-wine a quart, juice of pellitory of the wall a pint, spirit of wine half a pint, *Sal prunella* an ounce; mix and dissolve them, pour off the clear, and sweeten with white sugar. The dose is six spoonsfull morning and night.

*For the king's-evil.*

296. Take roots of pile-wort a sufficient quantity; bruise and boil them in hog's-lard till they are crisp, after which press them hard out; and

and boil, in the like manner, as many more fresh roots, and press out MEDICINE. again; do this the third time, and keep the ointment, to anoint with  morning and night.

*An approved remedy for the king's-evil.*

297. Set a quart of new milk on the fire till it just boils up; then take it off, and put into it two spoonsfull of the best honey, and stir it till it be dissolved; set it on the fire again, and let it boil a little. Then divide it into 4 parts, and drink one part warm, early in the morning, another about 10 of the clock, the third about 4 in the afternoon, and the last a little before bed-time. Do this, daily, for two or three months, except when you purge, which must be once a week, with *Caryocostinum*. Dress the sores, if they run, with any drawing sear-cloth, or a plaister of *Burgundy pitch*. The medicine, tho' not very promising, is very famous, from the many cures perform'd with it by a lady.

*An useful drink to correct sharp or scrophulous humours.*

298. Boil two ounces of choice barley, well wash'd from its dust, in a quart of spring-water, till the grains begin to burst; then strain the decoction through a clean cloth, and let the patient use it for his ordinary drink.

*For the king's-evil.*

299. Take cuttle-bone uncalcin'd, and having scrap'd off the outside, dry the white part; and of this, finely powder'd, give half a dram for a dose in mallow or barley water.

*A cure for the king's-evil.*

300. Take a handfull of *Paronychia folio rutaceo*, called rue-whitlow-grass, and boil it, every morning, in a quart of small beer; strain it, and drink it for ordinary drink. It wastes the peccant humour, appeases the pain, discusses the unbroken tumours, and heals the broken ones.

*For scrophulous tumours in children.*

301. Put two handsfull of figwort to a pottle of small ale; of this give a quarter, or half a pint for a dose. The operation will be promoted, by quenching, seven or eight times, in this liquor, a gad of steel, about eight or ten inches long.



## MEDICINE.

Helmont's  
laudanum, a  
general reme-  
dy.

*The Laudanum of the younger Helmont.*

302. Take of opium a quarter of a pound; and of the juice of quinces four pounds at the least; cut the opium very small, and mix it well with the juice, first made luke-warm; and then digest them with a moderate heat, for eight or ten days. After this, filter the tincture; and infuse therein of cinnamon, nutmegs, and cloves, of each an ounce, or an ounce and half; and let them stand for three or four days, or a week longer; then filter the liquor once more, having just let it boil a very little, after the spices were put in. Now evaporate the superfluous moisture, till the remainder acquires the consistence of an extract; lastly, incorporate well herewith two ounces of the best saffron, reduced to fine powder; or as much of the extract as the same quantity of saffron would afford. The medicine might be brought to the consistence of a mass fit for pills; a form wherein I have often administered it; and upon occasion too, it might be kept liquid; and if that were the design, the evaporation must have been but gentle. The dose of the liquid sort may be from five drops to ten, as circumstances shall require; but of the pills, a less quantity must be used.

*For the leprosie.*

*For the lepro-  
sie.*

303. Take pomatum one ounce, flower of sulphur one dram, *Sal prunella* half an ounce; and having mixt them very well together, anoint the part affected therewith, from time to time, as there is need.

*A simple antimonial-remedy, that has often done much good, even in the leprosie, and continual fevers.*

304. Of fine crude antimony, in powder, give about one, two, or three scruples morning and evening, according to the age of the patient, in a little syrup of clove-july-flowers, or any such vehicle; or else mixed with fine sugar, enough to make it palatable. This may be continued for four or five months, if need require: but if the first dose prove beneficial to the patient, and the case not urgent, a scruple, or half a dram, may serve the turn; nor need the exhibition be continued for so long a time.

*An often experienced antimonial infusion.*

305. Take one ounce of powder'd antimony, tied up in a little linen bag, and hang it in a gallon of new beer or ale. This liquor, when 'tis ripe, let the patient use for ordinary drink; only, if by age or accident it grow sour, no more must be drank, lest the acidity of the liquor corroding the antimony, should make it vomitive.

## Medicinal Experiments.

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MEDICINE.



Limbs pain'd.

*To appease scorbutic pains in the limbs.*

306. Spread liquid styrax thin, upon silk, or very fine kid-leather; and keep it upon the part affected, till it dry up of it self, or till the patient has no more need of it.

*An experienced medicine for a contraicture, produced by keeping the limbs too long in an undue posture.*

307. Anoint well, once or twice a day, the part affected, with dogs-grease; chafing it in with a warm hand, and keeping the part warm afterwards.

*For the dysentery, and other sharp fluxes.*

308. Take the stalks and leaves of flea-bane, dry them gently till they be reducible to powder; of which give about one dram at a time, twice or thrice a day, in any convenient vehicle; or else incorporate it with conserve of red roses.

*Looseness.*

*A remedy often used with success in fluxes, and dysenteries.*

309. Cut fresh roots of bistort into thin slices, and moisten them well with fair water and wine, to make them more soft; then press out the juice strongly; and of this give about three or four spoonsfull in red wine, or some other convenient liquor.

*A successful medicine for fluxes of the belly.*

310. Mix with rice-meal about a fifth part of finely powder'd chalk; boil these in water, or in milk, like a hasty-pudding, to be moderately season'd with sugar, and powder'd cinnamon; and let the patient eat it at meals.

*For a looseness.*

311. Boil a convenient quantity of cork in spring-water, till the liquor taste strong thereof; and of this decoction let the patient drink a moderate draught, from time to time, till he finds himself reliev'd.

*For a looseness.*

312. Mix up 15 grains of powder'd rhubarb, with half a dram of diascordium; and let the patient take it either going to bed, or early in the morning, after his first sleep.

*An experienced remedy for sharp fluxes of the belly.*

313. In a pint of new milk dissolve two ounces of loaf-sugar, and about the bigness of a walnut of mithridate; give this mixture, moderately warm, for a glyster, to be repeated if there be occasion.

*Medicinal Experiments.**To stop fluxes, and the whites.*

314. Give the patient, from time to time, a moderate quantity of a decoction of half an ounce of ising-glass, in about a pint of new milk.

*For fluxes, especially those caused by sharp humours.*

315. Thoroughly drench a toast in good oil-olive, and let the patient eat it.

*An excellent remedy against fluxes.*

316. Boil unsalted butter gently, till a considerable part be consumed, skimming it from time to time, whilst it stands over the fire: of this butter melted, give now and then a considerable quantity, as the patient is able to bear it. This medicine was very successful in Ireland.

*An often try'd glyster in fluxes, especially from sharp humors, and in some other distempers of the bowels.*

317. In a quart of new milk, boil two small spoonsfull of grossly powder'd rice, to the consistence of cream, then dissolve in it two ounces of sheep-suet; and having strain'd it, give it, at once, for a glyster.

*For suppression of the Menfes.**Menfes suppressed.*

318. Give, for three mornings together, about the expected time of the evacuation, a dram of the galls and livers of eels, dried and powder'd.

*A good medicine to increase milk in such as give suck.**Milk to increase.*

319. Make pottage with lentils, or vetches, and let the patient use it freely.

*To increase milk in nurses.*

320. Dry well-cleaned earth-worms, so that they may not smell ill, and yet be pulverable. Of these, reduc'd to powder, give half a dram, or two scruples, for a dose, in wine, or any other proper vehicle.

*For disorders in the nervous system.**Nervous disorder.*

321. Take of the fresh roots of the male piony one ounce, of the seeds of the same plant two drams; and with a sufficient quantity of the syrup of piony, or some conserve of a like nature, beat them up into an electuary; of which the patient may take the quantity of a small nutmeg, or more, twice or thrice a day.

*For obstructions, and several diseases thence proceeding.**Obstructions.*

322. Let the patient drink, every morning fasting, a moderate draught of his own urine, newly made, and whilst 'tis yet warm; forbearing food for an hour or two after it.



## Medicinal Experiments.

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MEDICINE.

*A choice medicine for the palsy.*

*The palsy.*

323. Take sarsaparilla a pound and half, bark of guaiacum, china in chips, of each two ounces and a half; boil all in six pints of water, to the consumption of a third part: at the end add raisins of the sun ston'd 4 ounces, liquerise bruise'd one dram, twelve fat figs; boil and strain it. This is to be used warm for ordinary drink.

*For a weakness in the hands, arising from the palsy, or rheumatism.*

324. Take the tops of rosemary, and, bruising them a little, make them up into a ball of the bigness of a small orange. Let the patient often roll one of these balls between his hands, and, for several hours in a day, grasp one of them in the hand affected, that it may grow hot there, and transmit its effluvia into the part. Continue this course as long as the distemper requires.

*An external remedy for paralytic disorders.*

325. Make a strong decoction of rosemary-leaves, or flowers, and let the patient long hold the part affected in the liquor, kept very warm. If, after several trials, this medicine prove ineffectual, mix ten drops of oil of worms with it, and 4 or 5 drops of oil of turpentine; and with this mixture warm'd, anoint the part from time to time; or else let the patient keep the part, for a good while together, in warm rain-water, to dissolve the scorbutic salts.

*For the pleurisie.*

326. Cut green broom-tops short, and therewith fill a pipkin, of a pint and half, and with ale; boil it softly, till it be wasted to two or three spoonsfull; and then it will look black, like treacle, and be thick. When 'tis enough, and cold, add as much mithridate as a nutmeg; mix it well, and give it the patient, warm, in bed, and let him sweat for three hours, or more, after it. If it relieve not at first, repeat it next day.

*An experienced medicine for the pleurisie.*

327. Take several balls of fresh stone-horse-dung; cover them whilst they are warm, with good white-wine; let them stand a little, and then press out gently, through a clean linen cloth, as much liquor as the mixture will readily afford; and of this, somewhat warm, give a moderate draught from time to time.

*The essence and salt of hartshorn, experienced medicines in the pleurisie, disorders of the brain, &c.*

328. Distil hartshorn, broken on an anvil into pieces about the bigness of the little finger, in a sand-heat; and afterwards separate the spirit and volatile salt from the reddish, lighter oil, and free them

O o o o 2

by

**MEDICINE.** by two rectifications from phlegm and feculencies, in tall glasses, with a very gentle heat. The dose is from eight or ten drops of the spirit, or as many grains of the salt, to sixty times the quantity of either, in any vehicle, except milk, that is not acid. These medicines have been serviceable in the epilepsy, convulsions, in fevers, obstructions of the spleen, liver, womb, &c. and commonly prove diaphoretic, without heating the blood too much. Only they shou'd not be exhibited when the *prima via* are block'd up by gross humours. 'Tis proper to preserve this salt in the spirit; otherwise 'tis apt to fly away.

*An experienced medicine for the pains of the hemorrhoids.*

*The piles.*

329. Take the sole of an old shoe, worn by some man that walks much, cut it in pieces, and burn it to a friable, tender coal; reduce this to impalpable powder, and then, with a sufficient quantity of unsalted lard, make it into an unguent, wherewith the part affected is to be anointed from time to time.

*For the hemorrhoids.*

330. Use a suppository of hogs-lard, bacon, or goose-grease.

*For the hemorrhoids.*

331. In the yolk of an egg, or some convenient syrup, or conserve, give from half a dram, to one dram, of flower of brimstone, once, or, if the case be urgent, twice a day. The powder may be, also, given in milk to those who like it.

*An internal remedy for painful hemorrhoids.*

332. With about two scruples of choice sulphur vive, mix a little sugar, and give this dose once or twice a day.

*For the pain and tumour of the hemorrhoids.*

333. Take fresh leeks, the whole plant, shred small, fry them well with fresh butter, till they become fit for a cataplasm, to be apply'd very warm to the part affected, and renewed from time to time.

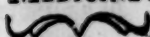
*An useful medicine for the pain of the hemorrhoids.*

334. Make up flower of brimstone, and an equal weight of fine sugar, with a solution of gum-dragon, into tablets that may weigh about a dram each; one of which may be given twice a day.

*For the pain of the hemorrhoids.*

335. Mix up *Album Gracum*, reduced to an impalpable powder, with a sufficient quantity of goose-grease; and by grinding it well in a leaden mortar, bring it to a black ointment, to be apply'd moderately warm to the part affected.

*An*



*An experienced remedy for unbroken hemorrhoids.*

336. Incorporate calcin'd oyster-shells, with as much honey as will make up the powder into an ointment; with which the part affected is to be tenderly anointed from time to time.

*A very successful medicine for the hemorrhoids.*

337. Take maiden-leeks, that is, those which have never been transplanted, and casting away the green part, make of the bulbous one, and a sufficient quantity of whole oatmeal, a caudle, whereof let the patient eat plentifully.

*For the pain of the hemorrhoids.*

338. Boil a handful of yarrow, in about a pint and half of posset-drink, in a cover'd vessel, till it be strong of the plant; and of this decoction let the patient drink, pretty plentifully, from time to time.

*For the pain of the hemorrhoids.*

339. Take of mastic, olibanum, aloes, and myrrh, of each a like quantity, powder and mix them very well; then lay a sufficient quantity of this upon a pledget of lint, moisten'd thoroughly with spirit of wine, over a few well-kindled coals, that the powder may melt, and be clapt hot to the pit of the stomach, or navel.

*For the pain of the hemorrhoids.*

340. Boil a quart of new milk for a while; then taking it off the fire, presently put it into some open-mouth'd vessel, and let the patient sit to receive the fume of it.

*To appease the pains of the hemorrhoids.*

341. Roast two fresh eggs pretty hard, then peel off the shells, and mince them. To these add two pippins, the cores being first taken out, that have been thoroughly roasted; incorporate them very well with the eggs, reducing all to a kind of cataplasm, to be apply'd very warm to the part affected.

*For pains of the hemorrhoids.*

342. Boil half a dram of good flower of brimstone, a little, in new milk, and let the patient take, in the morning fasting, both the liquor and the powder, for many days successively. The like dose may, upon occasion, be taken between 4 and 5 in the afternoon.



## Medicinal Experiments.

*An experienced remedy for the piles.*

343. In 4 ounces of spring-water, dissolve one dram of salt of tartar, and apply soft rags dipt in it, warm, to the part affected, shifting them from time to time.

*For the piles.*

344. Take the powder of earth-worms, wash'd in white-wine, and incorporate it with as much hens-grease, as will serve to make it up into an ointment. Apply this to the part affected.

*For tumours and pains of the hemorrhoids, not too much inflamed.*

345. Let the patient dip his finger in balsam of sulphur, made with oil of turpentine, and anoint the tumours, whether external or internal, once or twice a day.

*For the pains of the piles.*

346. Take of myrrh, olibanum, and common frankincense, of each a like quantity; having powder'd them, mix them very well, and let the patient receive the fume of this mixture, cast upon a chafing-dish of embers, in a close-stool, for about a quarter of an hour.

*To appease the pain of the hemorrhoids, whether internal or external.*

347. Take two parts of flower of sulphur, and one of sugar, very finely powder'd; mix them exactly together, and make them up with a sufficient quantity of mucilage of gum-dragon, into lozenges of about a dram each: of which you may give one at a time, thrice a day, or, if need be, 4 or 5 times.

*For the piles.*

348. Take balsam of sulphur made with oil of turpentine, and ointment of tobacco, equal parts; incorporate them well, and anoint the grieved place therewith.

*Aloetic pills that scarce occasion the piles.*

349. Give of the Frankfort angelical pills, from one scruple to two scruples, or more, for a dose.

*A medicine for the pain and tumour of the hemorrhoids.*

350. With rags dipt in the patient's own urine, foment the parts affected, and then anoint them with ointment of populeum. This do three or four times a day; and if the tumours be internal, you may inject a little of the urine.

*A remedy, by which many dogs bitten by a mad-dog, have been preserved from running mad.*

351. Take three whole plants of the herb called rose-plantain, or by some, star-plantain, i. e. *Lychnis salmantica* Clus. and having chopt them small with a convenient quantity of butter, let the bitten dog take it for the first day; the second day give him 5 plants order'd as before, and the next day 7. Poisons to cure.

*Against the bites of vipers, and other venomous creatures.*

352. As soon as ever the person is bitten, a hot iron may be held as near the wound as the patient can possibly endure it, till it has drawn out the poison.

*An approved medicine for the bite of a viper.*

353. Apply white hore-hound, beaten into the form of a poultis, to the part affected; and give the patient a spoonfull or two of the juice of the same herb to drink.

## Elixir Salutis.

354. Take of the seeds of anise, sweet fennel, coriander, and parsley, of liquorice, and choice leaves of senna, each two ounces; of raisins of the sun one pound; of elecampane-roots, and guaiacum-wood, of each one ounce. Mix these ingredients, and pour on them two quarts of *Aqua vita*; let them infuse for 48 hours; then put them all into a hair-bag, and squeeze them strongly in a press, and pass what is strained through an hippocras bag, after the liquor is settled. Keep this in bottles, well stopp'd, in a cool place, and give of it two or three spoonsfull at a time, in the morning fasting, and, if need require, at bed-time. Purging medicines.

*A purging electuary, especially for children.*

355. Take an ounce of choice rhubarb, reduced to fine powder, and eight ounces of very good currants pick'd, wash'd, and rub'd dry; beat these together in a marble mortar for near two hours. Of this electuary let the patient take about the bigness of a chestnut in the morning fasting, and at bed-time: or, if the case be very urgent, the medicine may be taken thrice in 24 hours.

*A pleasant purge for children, and delicate persons.*

356. In the yolk of an egg, dissolve, by rubbing in a clean stone mortar, about six grains of rosin of jalap finely powder'd; and when the solution is made, gradually incorporate with it two or three ounces of succory-water; which, by this operation, will be made into a kind of emulsion: sweeten it at pleasure, and give it in a morning fasting.

## MEDICINE.

*A try'd way to make an artificial wine, that is soon drinkable, and serves to keep the body soluble.*

357. Pour a gallon of boiling water upon three pounds of raisins of the sun, ston'd and well bruis'd; by squeezing and pressing, get out the juice; and having strain'd it, add thereto a pound of brown sugar-candy.

*An approved outward medicine to cause rest without opiates.*

*Rest to cause.*

358. Take of rose-water eight ounces, good wine four ounces, strong vinegar two ounces; mix these well, and having warm'd stupes in the liquor therewith foment the part affected; laying them on moderately warm, and taking them off when they begin to grow cold: keep fomenting between a quarter, and half an hour, before the patient composes himself to rest.

*A good medicine for rheums, or a cold newly taken.*

*Rheums.*

359. To four ounces of spring-water put three leaves of colts-foot, a pugil of maiden-hair, and one dram of stick-liquorice: when the water is ready to boil, put in the fore-mentioned ingredients; let it boil a little, then take it off the fire, and having presently strain'd it, let the patient drink it hot, like tea, whilst he is in bed: do this three or four nights successively.

*A very good Syrup for thin rheums.*

360. Take the syrups of jujubes, dried roses, and of corn-poppies-flowers, of each a like quantity; mix and use them as necessity requires.

*A powerful medicine to stop sharp rheums.*

361. Take a dram of Japan earth, and make thereof a decoction in five or six ounces of white-wine, or some distilled water. Of this give two or three spoonsfull night and morning.

*A successful remedy for a kind of rheumatism, and a contracture of the limbs that followed upon it.*

*The rheumatism.*

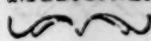
362. Take the inward bark of an elder-tree, cut it into small bits, and with them, loosely placed, fill about the third part of a bottle; then pour in as much small ale, or beer, as will fill up the remaining part of the vessel; stop it well till the liquor taste strong of the bark; and let the patient drink a draught once or twice a day; or, if he can, let him take it as a diet-drink.

*Ens veneris, an experienced specific for the rickets.*

*The rickets.*

363. Calcine good Dantzick, or rather Hungarian vitriol, till the calx become of a dark red, or purplish colour; then thoroughly dulcify it, by



by repeated washings in warm water, dry it, and mix it exquisitely with MEDICINE.   
 an equal weight of pure sal-armoniac in powder; put the mixture into a glass retort, able to hold above three times the quantity, and sublime it in a sand-furnace, by degrees of fire, for ten or twelve hours; increasing the fire at the last, till the bottom of the retort be red-hot. If what is sublimed, which is the medicine, be not of a good yellow, return it to the remainder, mix it well therewith, and sublime it once more. The dose is two or three grains to little children, ten or twelve to grown persons, and sometimes twenty or thirty, in distilled water, or small-beer, but not in milk. It may be given at any time, upon an empty stomach; but I most commonly give it at bed-time. When it operates sensibly, 'tis by sweat, and, sometimes, by urine. I exhibit this medicine, also, in fevers, and other diseases, to procure sleep, which it does more safely than opiate preparations. 'Tis, also, powerful against worms, obstructions of the *menfes*, and to strengthen the appetite.

*An effectual medicine for the roughness of the lips, and to heal parts that have the scarf-skin worn off.*

364. Take two parts of wax, and one of fresh butter, melt and incorporate them over a gentle fire; and let the mixture drop into small cakes, upon a glazed tile, dipt in water, or a piece of wetted white paper. *Roughness of the lips.*

*To take off the heat and roughness of the skin, especially on the lips.*

365. Anoint the part affected with fresh cream.

*For a rupture, especially in a child, or young person.*

366. Reduce the root and leaves of dove's-foot-crane's-bill, to fine powder; and of this let the patient take about half a spoonfull at night and morning, for three or four weeks together; washing it down, each time, with some spoonsfull of red wine. *Ruptures.*

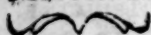
*For ruptures in the belly, especially in children.*

367. Having well cleansed some Solomon's-seal roots, scrape one ounce of them into a quart of broth, and let the patient take a mess of it for his breakfast; or else give half a dram, or two scruples, of the powder of it, at a time, in any convenient vehicle.

*An useful drink for a beginning scurvy.*

368. To a quart of small-beer, put over-night, about a handful of scurvy-grass-leaves; and let the patient drink this liquor at dinner, for six or eight weeks together. *The scurvy.*

## MEDICINE.



*An excellent drink for the scurvy.*

369. Let two handsfull of water-trefoil work in about eight gallons of wort, instead of hops; and let the patient use it for his ordinary drink.

*For the scurvy.*

370. From the fresh gather'd tops of fir, a little bruis'd, abstract spirit of wine; and with this liquor draw a deep tincture from other fresh tops; of which tincture reduce some part into an extract, whereof to form pills; keep these, the tincture, and the impregnated liquor apart, to be employed separately, or conjointly, as occasion may require.

*For scorbutic, and other pains in the limbs.*

371. With red and unsophisticated oil of peter, anoint, from time to time, the part affected.

*An experienced remedy for a short breath.*

*Short breath.*

372. Take of choice castor powder'd, two, three, or four grains; mix this with ten or eleven grains of *Gascoign's* powder, and some little syrup, or conserve; and when taken, let it be wash'd down with a mixture of five drams of peny-royal-water, and two drams of compound bryony-water.

*An experienced medicine for want of sleep, proceeding from great heats in the head.*

*Sleep to procure.*

373. Take the scrapings of the palest carrots, enough to make a cataplasm, of about two inches broad, and of the thickness of a half-crown. Let the patient apply this, in a piece of double linen, to his throat, so that it may reach to the jugular vessels on each side, when he goes to bed, and let it lie on all night; if the first application do not prevail, 'tis to be apply'd the following night; and so a third and fourth time, if need require.

*An experienced medicine for the small-pox, especially in children.*

*Small-pox.*

374. Take the little balls of fresh sheeps-dung, and having freed them from straw, dust, &c. put a handfull of them, thus cleans'd, into a quart of good white-wine; and in a vessel well stop'd, let them infuse in a moderate heat, till the liquor be well impregnated. Strain this infusion, and give of it warm about a spoonfull at a time, once in two or three hours, or oftener.

*For heat about the orifice of the stomach.*

*Disorders in the stomach.*

375. Make a syrup with the juice of housleek and sugar, and give about one spoonfull of it from time to time.

## *A stomachic tincture.*

376. Take agrimony two drams, tops of the lesser centory one dram, coriander-seeds bruised one scruple, saffraſas ſhavings and bark one dram, gentian-root half a dram, zedoary-root ten grains; pour upon theſe three quarters of a pint of boiling ſpring-water, cover it, and let it ſteep for twelve hours, then ſtrain it, put it in a bottle; and having let fall a drop of oil of cinnamon upon a lump of ſugar, put it into the liquor. The doſe is three ſpoonsfull twice a day, an hour or two before meals.

## *An excellent external remedy to ſtrengthen the ſtomach.*

377. Take wormwood, mint, and mugwort, and by beating them well in a ſtone mortar, make a cataplaſm, to be apply'd ſomewhat warm to the ſtomach, and kept upon it for a pretty while.

## *An often try'd remedy to ſtrengthen the ſtomach, and take off griping pains in or near it.*

378. Take the *Emplaſtrum ſtomachicum* of the London diſpenſatory, and let fall upon it five or fix drops of oil of cinnamon; rubbing it well over with your finger, and ſo apply it to the patient's ſtomach: as ſoon as it grows dry, remove it; and having ſcrap'd the plaſter, and warm'd it on the wrong ſide, let fall ſome drops of the oil of cinnamon upon it, and apply it again.

## *A plaſter to ſtrengthen the ſtomach and cheſt.*

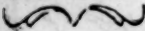
379. Take of cinnamon, nutmegs, cloves, and mace, of each a ſufficient quantity, powder'd; ſtrew ſome of the powder over the bottom of a deal box, of a convenient length and breadth, and fit it with a cover to ſhut cloſe; upon this powder lay a piece of clean flanel well dry'd, and ſtrew it over thinly with ſome of the ſame powder; then lay on another piece of the like flanel, of the ſame dimenſions with the former; and upon that likewise, if need be, ſtrew a little more powder. This done, ſhut the box till the time of uſe, and then take out one of the pieces of flanel, and having lightly duſted off the powder, lay it on the patient's breaſt, ſtomach, and belly; and let it lie on for ſome days. When you perceive its virtue begin to languish, ſubſtitute the other piece of flanel, and put the firſt in the box to receive new virtue; and ſo proceed, alternately, as long as you need the medicine; adding now and then ſome freſh powder occaſionally. Each piece of flanel ought to be long, and large enough to cover the breaſt, and to reach from about the paps to the navel, or lower.

## *To give eaſe in the pains of the ſtone, even that of the bladder.*

380. Take the transparent ſpar that grows upon the veins of lead-ore, and having reduced it to fine powder, give from half a dram, to

*The ſtone*



 MEDICINE. a whole dram of it at a time, in a moderate draught of some convenient vehicle. That which the diggers name cawk, being white and opake, is not the medicine I mean, but the transparent matter, which easily breaks into smooth fragments, and in the fire cleaves into several pieces, smooth and prettily shaped.

*A safe and easy medicine in fits of the stone.*

381. Take sack, or claret-wine, and by shaking, or otherwise, mix with it an equal quantity of oil of walnuts; and of this mixture give from four or six, to eight or ten ounces at a time, by way of glyster.

*For the stone.*

382. Give of the seed of flix-weed, about as much as will lie upon a shilling, either whole, or grossly bruised, in any convenient vehicle.

*An anodyne glyster in the stone.*

383. Take marsh-mallow roots half an ounce, leaves of the same, mallows, and mullein, of each one handfull, camomile-flowers two pugils: boil them in a sufficient quantity of water to ten ounces, strain, and add the yolks of two eggs, and oil of camomile an ounce and half; mix and make a glyster.

*An excellent medicine in fits of the stone.*

384. Boil less than a handful of red chick-pease, or cicers, softly in a quart of spring-water, till the liquor be red, and well impregnated with the seeds: strain this decoction, and sweeten it with syrup of marsh-mallows, out of which all the stronger diuretics are left.

*For the stone.*

385. Sweeten a quarter or half a pint of simple arsmart-water, with a little sugar, or some convenient syrup; aromatize it with a little nutmeg, and give this mixture for one dose.

*For the stone and gravel in the reins and bladder.*

386. Take equal weights of common daucus-feed, and of burdoc-feed; and having mixt these together, put one ounce of the mixture to a gallon of small ale, and let the patient use it for constant drink.

*A good liquor to use, as drink, in a long fit of the stone.*

387. Make posset-drink of three or four parts milk, and one of white-wine. Into two quarts of this posset-drink, scrape a nutmeg or two; add a little juice of lemmon, and, if you please, sweeten it a little with syrup of marsh-mallows. Take of this drink a considerable quantity at a time, and use it often in a day.

*A good medicine for the stone.*

388. Sweeten a pint, or a quart, of new ale with pure honey, and boil it to the consumption of about one half, skimming it well from time to time. Then dissolve in it the yolk of a new laid egg; and let the patient drink a large draught of this mixture once or twice a day, till he find relief.

*A serviceable medicine in an actual fit of the stone.*

389. Take the decoction, made according to the London dispensatory, for the syrup of marsh-mallows, but with half the quantity of the ingredients. This decoction being well clarified, let the patient take of it warm, six, eight, or ten ounces at a draught, from time to time.

*A cure for the stone; taken out of the history of Barbadoes, written by Mr. Lygon.*

390. After the stoppage of urine for more than 14 days, the following medicine did not only break, but bring away all the stones and gravel. And in about three weeks after, the like pains returning, the same medicine had the like effect, within ten hours after the taking thereof.

Beat the dry pizzle of a green turtle, or tortoise, which lives in the sea, to powder; and take of it as much as will lie upon a shilling, in beer, ale, white-wine, or the like; and in a very short time it will perform the cure. These creatures are to be had easily, both at the Caribee and Lucaick-islands.

*To expel the stone in a fit.*

391. Dissolve a large proportion of crabs-eyes powder'd, in good white-wine vinegar; and of this drink let the patient take from two spoonsfull, to five or six at a time.

*For the stone.*

392. Give every morning fasting, and every night going to bed, half a dram of the powder of winter-cherries, in a draught of parfly, or arsmart-water, or in a glass of white-wine.

*An often try'd medicine for the stone, whether of the kidneys or bladder.*

393. Take of pure white-wine, or Rhenish, and of fennel-water, each one pint; mix them, and add half an ounce of live wood-lice well cleansed, and one lemmon sliced; let them infuse in a vessel well stop'd, for four or five days, and then let the patient take about four ounces at a time twice a day.

*For the stone.*

394. Distil arsmart in a common rose-water still, and give some spoonsfull of the water in or before the fits.

*A chymist's secret for the stone.*

395. Take borax finely powder'd, and make it up with choice turpentine into pills, whereof one dose ought to contain from one scruple to two; wash these down with a few spoonsfull of the tincture of *Lignum Nephriticum*, made in water, or of cochineal; or if the case be urgent, you may give from twenty to thirty grains of the borax, and about a fifth part of myrrh, dissolved in two spoonsfull of the tincture of *Lignum Nephriticum*.

*To make a nephritic tincture, often found to relieve in the stone.*

396. Calcine oyster-shells till they be very white; of these take two parts, and one of *Rhenish*-wine tartar; pulverize them apart, and mix them diligently; pour on the mixture a little fair water, and let the ingredients work on each other till the conflict be over; then stir the mixture, and pour on more liquor; and when the effervescence ceases, put on a little more, and so proceed till no conflict be made. Evaporate it to a kind of soft mucilage; digest this a while, decant the liquor, and filter it, and you will have it, if it be not too phlegmatic, of a fine red colour. Of this the dose is from ten or fifteen, to thirty drops, or more, in any convenient vehicle.

*An useful aliment for such as are troubled with pains of the stone.*

397. Let the patient eat five or six onions roasted, and sparingly butter'd, either in the morning, at meals, or other times, if the case be urgent. The distilled water of onions is, likewise, useful in the same distemper.

*The medicine of a famous empiric for the stone.*

398. Take amber, sea-horse pizzle, and nitre, of each a like quantity, (but in case of ulcerated kidneys, put only half the quantity of the amber) and an eighth part of nitre. Pulverize each apart, and make them up into pills with *Chio* turpentine; take six or seven pills (of about ten to a dram) morning and evening.

*For the stone.*

399. Take *Strasburgh* turpentine two ounces; grind it well with the yolks of eggs, and mix therewith the following syrup. Take water a pint and half, *Sal Prunella* an ounce and half; mix, dissolve, and with a pound of honey, boil all into a syrup. The dose is two or three spoonsfull morning and night.



*An excellent medicine for the stone in the bladder.*

400. Take powder of comfrey-roots an ounce and half, marsh-mallow roots three ounces, liquerife-powder two drams, seeds of daucus of *Cret* two drams, seeds of purslane, and of winter-cherries, each half a dram, nutmegs two drams, saffron one dram, the species *Diamargariton frigid.* six drams, syrup of marsh-mallows four ounces; mix and make a soft electuary; of which let the patient daily take the quantity of a walnut. It is good against the stone in the reins and bladder, but chiefly against the latter; as also against the strangury, dysuria, &c.

*A famous lithomists receipt for a soft stone in the bladder, after it has been crush'd and broken.*

401. Take the waters of melons, citruls, drop-wort, and parsley, the syrup of the five opening roots, and *Syrup. Byssantinum*, of each two ounces, compound oxymel one ounce; mix these, and take a fourth part of the whole in the morning fasting, and eat nothing after it for eight hours; take another fourth at night going to rest, and the remainder on the day following, after the same manner. Then on the third day,

Take lenitive electuary three drams, syrup of damask-roses two drams, the pulp of tamarinds one dram, dissolve them in three ounces of whey; and drink the whole in the morning early. On the fourth morning take a dram of the following powder, in a quarter of a pint of the following apozem, and half an ounce of the oil of sweet almonds.

Take sandiver, or rather wood-ashes, the powder of scorpions, or of well-cleansed earth-worms, *Lapis Spongia*, and *Lapis Judaicus*, *Acorns*, the seeds of marsh-mallows, gromwell, mil-foil, saxifrage, of each a dram; the seeds of lettuce, and the four greater cold seeds, of each half a dram, the troches of winter-cherries, and pimpinel root, of each two drams; make the whole into a fine powder.

Take pellitory of the wall, and marsh-mallow root, of each a handful, parsley-seed, and liquerife, of each half an ounce, the seeds of winter-cherries an ounce; boil them in two quarts of rain-water, and one of white-wine, till half is wasted, and sweeten the remainder with honey. Then, on the fourth day, eat a hedge-sparrow with your supper, and afterwards anoint the loins, *Pubes*, and the whole region of the kidneys, with the oil of citron-seeds, and of scorpions: or these oils may be injected into the bladder. And thus continue the use of the powder, apozem, sparrow, and the oils every day, till the sand or fragments of the stone come away with the urine.

*For a strain.*

402. In the strongest vinegar boil a convenient quantity of wheat-bran, to the consistence of a poultis. Apply this, as early as may be, to the part affected, and renew it when it begins to grow dry.

*For*

## Medicinal Experiments.

*For a fresh strain.*

403. Take wormwood, and pound it very well in a stone-mortar; then put into it as much of the whites of eggs, beaten to water, as will make it into a poultis, to be applied to the part affected.

*A strengthening plaister after a strain, or when there is any weakness in the joynt.*

404. Melt down together, and incorporate two parts of diapalma, and one part of *Emplastrum ad Herniam*; spread this mixture (not very thick) upon leather, and lay it to the joint to be strengthened.

*For a fresh strain.*

405. Make up clay with as much vinegar, as will bring it to the consistence of a stiff cataplasm: then warm it a little, and apply it to the part affected.

*For a fresh strain.*

406. Take four ounces of bean-flower, and two ounces of wine-vinegar; of these make a cataplasm, to be applied a little warm to the part affected: but if this should prove too sharp, boil two drams of litharge a little in the vinegar, before you put in the bean-flower.

*For a recent strain.*

407. Boil a handful of red-rose leaves in a pint of claret-wine, for a little while, in a close vessel, till the liquor be strong of the plant. In this, well heated, dip a piece of linen or flanel, and wringing out the moisture, double it, and apply it hot to the part affected; using a fillet to keep it on.

*My lord Bacon's experienced medicine for a recent strain or bruise.*

408. Boil a handful of fresh wormwood, in a sufficient quantity of strong ale, to the softness of a poultis; then take it off the fire, and when you apply it, which you should do whilst 'tis very hot, put to it a spoonfull or two of common brandy.

*A plaister for a recent strain.*

409. Take equal parts of the plaisters called diapalma and oxycroceum, make of them a compounded plaister, to be spread upon thin leather, and apply it to the part affected; renewing it, if need be, twice a day.

*A remedy for a recent strain.*

410. Take two spoonsfull of vinegar, and beat into it very well the white of an egg; and spreading it upon flax, or tow, apply it to, and keep it on the part affected.

*For a fresh strain.*

411. Boil bran in wine-vinegar to the consistence of a poultis; apply it warm, and renew it once in twelve hours, for two or three times.

*To strengthen a part weakened by subluxation.*

412. Spread *Emplastrum Divinum* upon soft leather, and apply it; keeping it on for some time.

*An effectual medicine for a strain.*

413. Take comfrey-roots, beat to a pulp, half a pound, powder of Japan earth four ounces, spirit of wine a sufficient quantity; mix and apply it to the part.

*A plaister to strengthen the joints after the gout, and hasten the going off of the pain.*

414. Take of paracelsus and diapalma, of each a like quantity, melt and incorporate them exactly together, and spread the mixture, very thin, upon fine leather, to be us'd as a plaister to the part affected.

*A medicine, almost specific, for a tenesmus.*

415. Mix balsam of sulphur terebinthinated with linseed-oil, or some other convenient oil, till the balsam be thereby so far allay'd, that the patient may well endure it; and then let him dip his finger therein, and use it as a small suppository two or three times, or oftener in a day.

*Tenesmus.*

*An experienced medicine to kill tetter and the itch.*

416. Take of flower of brimstone, ginger, and burnt-alum, of each a like quantity; mix them well, and of this mixture incorporate as much with new unsalted butter, as will bring it to the consistence of an unguent. With this anoint the part affected, as hot as the patient can well endure it, and let it stay on all night; the next morning wash it off with celandine-water. But when the patient goes to bed, he is to take a dose of some alexipharmic medicine, as *Gascoign's powder*, &c. to keep the humour from the mass of blood: he is, also, to bathe the part often in a day, with celandine-water.

*Tetter.*



## MEDICINE.

*Tooth-ach,  
and other disorders in the  
teeth.*

*A remedy almost specific for the tooth-ach.*

417. Into a quart of red wine, put one dram of alum, and another of acorns, a dram and half of galls, and half a handfull of dry'd red rose-leaves. Boil to the consumption of near half, and then take it from the fire; strain it, and dissolve in it a dram of *Acacia*, cut small; and with this liquor, a little hot, wash the part several times in a day. 'Tis also excellent to fasten loose teeth, being used in the same manner.

*An useful remedy for the tooth-ach.*

418. Let the patient lie on the ear that is opposite to the part affected, and into the other ear let fall two or three drops of the freshly exprest juice of rue, a little warm, and stop the ear lightly with fine black wool, or cotton.

*A very successful external remedy for the tooth-ach.*

419. In the decline of the moon, in *August*, take the fruit called hipps, with all the fuzzy stuff that grows upon it; and wrapping it up in a piece of thin sarsenet, tie it upon the arm, of the same side with the part affected, and keep it on as long as there is need.

*For the tooth-ach.*

420. Take a handfull of red sage, and a handfull of clary; shred them small, beat them, and sprinkle them with *May* dew; then strain out the juice, put it in a glass bottle, and set it in the sun in a window; and when you use it, put three drops into a spoon, heat it over a candle, and drop it, blood-warm, into the ear; and let the patient eat a crust of bread; wet either in broth or posset, and chew it upon the teeth that ache.

*A good composition to stop a hollow tooth, and appease the pain.*

421. Take two parts of fine sugar, and one part of black round pepper, both finely powder'd and mixt; put them into a silver spoon over two or three well-kindled coals: and when the sugar begins to melt, take off the spoon; and whilst the mixture is yet soft, form it into little grains, for size and shape suited to the part affected.

*To fasten loose teeth.*

422. Put mastic, finely powder'd, upon the end of a handkerchief, rub your teeth therewith twice or thrice in a day; and chew mastic often. Also boil pomegranate-flowers with mint or mastic, in claret wine; and gargle, or wash your mouth often with it.

*A medicine prescribed to K. Charles I. to fasten the teeth.*

423. To a pint of spring-water put four ounces of brandy; let the patient wash his mouth with the mixture every morning, and twice or thrice a day besides; and let him, in the morning, roll for a little while, a bit of roch-alum in his mouth.

*An*

## Medicinal Experiments.

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MEDICINE.

*An excellent medicine to fasten the teeth in scorbutic gums.*

424. Take of choice bole-armeniack two drams, choice myrrh one dram, roch-alum crude, half a dram, claret-wine one pint; boil these softly for a little while together; and let the patient use the strained liquor twice, thrice, or oftener, in a day.

*To fasten teeth made loose by the scurvy.*

425. Anoint the parts affected with oil of myrrh, made, *per deliquium*, with whites of eggs boil'd hard.

*A lotion to fasten the teeth.*

426. In a quart of spring-water, boil, for a while, one ounce of the best *Terra Japonica* in gross powder; and having filter'd the decoction, keep it close stopp'd for use.

*A good astringent liquor to fasten loose teeth.*

427. In a pint of red wine, infuse about half an ounce of *Terra Japonica*, till as much as will dissolve be taken up by the liquor; decant it from the feces, and keep it well stopp'd.

*An useful liquor to fasten the teeth, and prevent the tooth-ach.*

428. To a pint of spring-water, put half an ounce of clean sal-armoniack; and with the solution let the patient wash his mouth from time to time.

*An innocent dentrifice.*

429. Take mastic, and dragons-blood, of each a sufficient quantity; powder them, mix them together, and let the patient use them as a dentrifice.

*A good and innocent dentrifice.*

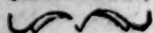
430. Rub the teeth with fine powder of red coral, two or three times a day; then wash them with water, in which *Sal Prunella* is dissolved.

*To prevent the tooth-ach, and keep the teeth sound.*

431. Let the patient frequently rub his teeth, moderately, with the ashes that remain in tobacco-pipes, after smoaking; washing his mouth with fair water not too cold.

*To appease the violent pains of the tooth-ach.*

432. Make up a scruple of *Pilula Mastichina*, and half a grain of laudanum, into two or three pills, for the patient to take at bed-time.



*For the tooth-ach.*

433. Apply a plaister of *Caranna*, between the bottom of the ear and the temples, on the side where the pulsation of the artery is the most manifestly felt.

*A good medicine for pain of the teeth, proceeding from rheum.*

434. Put of the powder of white hellebore, into a clean linen rag, like a nodule, about the bigness of a large pea; and let the patient hold it between his teeth, with his head and face somewhat inclined, that the rheum may run freely out of his mouth.

*For the aching of a hollow tooth.*

435. With oil of wax moisten a little cotton, and thrust it up into the tooth; letting it lie there till the pain be asswaged.

*A powerful and experienced topic for a sore throat.*

*Throat disorder'd.*

436. Take two new laid eggs, roasted moderately hard, and the pap of two well roasted pippins; beat them well together, and add an equal weight of posset-curd, made with ale. Having incorporated them all, apply the mixture very warm to the part affected; shifting it once in five or six hours.

*An approved remedy for a sore throat.*

437. Take verjuice of grapes one ounce, honey half an ounce, crude alum a dram and half, sea-salt half a dram; powder the salts finely, and incorporate them very well with the liquors into the form of a liniment: in this dip a long feather, and with it touch the part affected, gargling, between whiles, with a mixture of plantain, and red rose-water.

*An external remedy for a sore throat.*

438. Sew live millepedes between the foldings of a piece of linen, and apply them to the throat, in the form of a stay, to be kept on all night.

*A try'd remedy for a sore throat.*

439. Take bay-salt dry'd, and powder'd; put it into the folds of a rag, in a sufficient quantity to make a stay, to be ty'd about the throat; and apply it over night, as hot as the patient can endure it.

*For a sore throat, especially if inflamed.*

440. Take a little handfull of the leaves of common mallows, and eight or ten figs; boil these for a quarter of an hour in a pint of new milk, and let the patient use it very hot and often.



## Medicinal Experiments.

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MEDICINE.

*An experienced medicine for a sore throat.*

441. Take one dram of *Album Gracum*, burnt to perfect whiteness, and with one ounce of honey of roses, make a linctus, to be very slowly let down the throat.

*An experienced medicine for a sore throat.*

442. Into the foot of a worsted stocking, that has been long worn, put a sufficient quantity of good sea-salt, well dried, or decrepited; and this salt being put in warm, the stocking is to be tied about the patient's neck, and kept on all night. If by the next day the distemper be not removed, you may apply fresh salt, in the same stocking as before, on the night following.

*A try'd medicine for a sore throat, caused by acid humours in the internal parts of it.*

443. Boil half a handful of the leaves of common mallows, in a pint of new milk, for half an hour; then run it through a clean cloth, and let the patient use it, a little warm, three or four times a day, as a gargle: or else let him hold it in his mouth, suffering some drops to slide slowly down his throat.

*For a sore throat.*

444. Take a piece of greasie linen-cloth, which, being doubled, may make a bag, in form of a stay, to reach from one side of the throat to the other, and contain as much matter as may make it an inch thick. This bag being fill'd with common salt, is to be heated thoroughly, and apply'd to the part affected, as warm as the patient can conveniently endure; and when it begins to grow too cold, another like it, and well heated, is to be substituted in its room: and whilst this is cooling, the other may be heated, and made ready for use; so that the part affected be always kept in a considerable degree of warmth, for about 48 hours, if the remedy be so long needed.

*For a sore throat.*

445. Take the white of a new laid egg, by beating reduced into water; and with this mix so much conserve of red roses, as will bring it to a soft mass; whereof the patient is to let a little bit at a time melt leisurely in his mouth.

*For a sore throat.*

446. Take housleek, and having lightly beat it in a stone mortar, press out the juice hard; to this juice put almost an equal quantity of virgin-honey; mix them well, and add a little burnt alum, to give it a dis-

MEDICINE. discernible aluminous tast: let the patient take this from time to time, with a liquerise stick.

*An experienced medicine for sore throats.*

447. Take of scabious-water six ounces, of wine-vinegar a small spoonfull, of beaten mustard-seed, and of honey, each a spoonfull; stir and shake them very well together; then filter the mixture, and use it as a gargle.

*For a sore throat.*

448. Make a plaister of paracelsus, three or four fingers broad, and long enough to reach almost from one ear to the other; apply it to the part affected, so that it may touch the throat as much as possible.

*A gargle for a sore throat.*

449. To four ounces of plantain-water, add three or four spoonsfull of red rose-water, and mix very well with these the white of an egg beaten to a glair: sweeten the mixture with a small spoonful of white sugar-candy, and let the patient use it often.

*An excellent medicine for tumours in the throat, and some other parts.*

450. To a quart of new milk, put a handful of mallow-leaves, with as much of the leaves of night-shade, shred small; let them boil, till the herbs be tender. Then put into the milk as much crumbs of white bread, as being stirr'd well with the other ingredients, will bring all to the consistence of a poultis. This is to be spread upon a stay for the throat, or some other thing fitted to the part affected, and to be laid on as hot as the patient can well endure it; and when it begins to grow cold, it is to be succeeded by fresh, made very hot, as the case shall require.

*A remedy, almost specific, for the thrush in children.*

*The thrush.*

451. Mix fresh juice of houseleek with honey enough to make it sweet, and then add to it as much finely powder'd roch-alum, as will give it a little tartness; put some of this mixture, with a feather, down the patient's throat, as far as conveniently may be: the part affected shou'd also be touched once more within an hour after.

*For the thrush in young children, or a sore mouth.*

452. Fill an egg-shell with the juice of red sage, set it on hot embers till it boil, and skim it whilst any skum arises; then take the quantity of a pea of powder'd alum, and half a spoonfull of honey, and let this be put in the egg, and boil it a little; and when cold, rub the child's mouth herewith as often as you see cause.



*An excellent poultis to ripen tumours.*

Tumours.

453. Take eight ounces of figs, two ounces of white-lilly roots, and two ounces of bean-flower; boil these together in water, to the consistence of a poultis, to be spread thick, and laid warm upon the part; and to be shifted as often as it begins to grow dry.

*A medicine that cured an obstinate tumour of the knee.*

454. Take a green colewort-leaf, with red veins or streaks, and having cut the ribs flat, and almost level to the rest of the leaf, bruise it, and apply it to the part affected, renewing it once or twice a day.

*An effectual fomentation for swellings, accompany'd with sharp humours.*

455. To a gallon of spring-water, put as much dry'd sage, as will afford a strong decoction; into which, when it first grows hot, cast about two ounces of Castile-soap, and let it dissolve therein. With this foment the part for a good while together.

*An excellent plaister to discuss tumours that may be resolved, and ripen those that it cannot dissipate.*

456. Incorporate with the *Emplastrum de Saponi*, about a fourth part of *Balsamum sulphuris terebinthinatum*, and use it as a plaister; or in like manner, *Diachylon cum gummi*; renewing it once in two or three days.

*A plaister to discuss or ripen tumours.*

457. Take of yellow wax, frankincense, and rosin, of each four ounces; melt them together gently, and being strained, make up the mass into a roll for use.

*An excellent medicine for vapours, or fits of the mother.*

Vapours.

458. Take sagapenum, dissolved in vinegar of squills, strain'd through a sieve, and again thickned; ammoniacum, in like manner prepared, steel prepared, myrrh, and the fæcula of bryony, of each half a dram, *Englisb* saffron, castor, of each a scruple, borax two scruples, syrup of *Stachas* a sufficient quantity; mix, and make pills of a convenient bigness to be swallowed; of which take three morning and night.

*An useful plaister for the vapours, spleen, and shortness of breath, when 'tis nervous.*

459. Take two parts of strained *Galbanum*, and one part of *Assa fætida*, and make thereof a plaister, as big as the palm of one's hand; leaving broad edge quite round: and putting a large piece of cotton in the middle, apply it to the navel.



## MEDICINE.

*Veneral disease:*

*A rough emetic, by which the venereal disease has been often cur'd.*

460. Take good mercury sublimate, and Venice-treacle, of each one ounce; mix them together, and put them into a quart of spring-water; set them in *balneo*, to dissolve in a close vessel; and of this liquor well settled, let the patient take about half a spoonful, or a spoonful, but never above a spoonful and a half, in four ounces of warm small ale, in the morning fasting, and once in the afternoon, or evening; the stomach being empty. Every second day intermit, and give a gentle purge.

*Against a vertigo.*

*Vertigo:*

461. Take of cyprus-roots two ounces, of aniseed half an ounce; make of them a very fine powder, and give as much as will lie on a six-pence, in a spoonful of wine, beer, or ale; going to bed.

*A slow, innocent way of making vesicatories without cantharides.*

*Vesicatories to make.*

462. Put to a handful of crows-foot, about half a spoonful of mustard; and beat them very well together, to the consistence of a poultis, to be spread thick, and kept on for twelve or fourteen hours.

*A good medicine to raise blisters.*

463. Upon half an ounce of powder'd cantharides, put two or three ounces of good spirit of wine; let them lie together for four or five days, that the spirit may acquire a good tincture; then filter it, and dip into it a piece of linen cloth, six or eight times double, and of the figure and size desired. This cloth being thoroughly wetted, and cover'd with a melilot plaister, to keep it on, must be applied to the part. At the end of five or six hours, you may take off the plaister and the linen cloth, and find the blister rais'd.

*To raise a blister without cantharides.*

464. The seed of *Clemmatis Peregrina*, being bound hard upon any part, will, in an hour or two, have an operation, like that of another vesicatory.

*A water for ulcers and sores.*

*Ulcers.*

465. Take a solution of Venetian sublimate; and having made, with very good quick-lime, as strong a lime-water as you can, drop this upon the dissolved sublimate, till it precipitates no more reddish matter: as soon as you perceive the liquors act no longer upon one another, pour the mixture into a filter of cap-paper; which, retaining the orange-coloured precipitate, will let pass an indifferently clear liquor, to be kept stop'd in a glass vial. The part affected may be herewith wash'd, from time to time; and, if need be, cover'd with double linen cloths, wetted in the same.

*A famous empirical medicine for a stubborn ulcer.*

466. Lightly burn to ashes, the grofs stalks on which the red cole-wort grows, and, with any fit addition, make a cataplasm, to be apply'd to the ulcer; and shift it at reasonable distances of time.

*A try'd medicine to make a quick exfoliation of a carious bone.*

467. Take the thigh-bone of a man, and having burnt it black, reduce it to a fine powder, to be carefully strewed all over the part to be exfoliated, after some drops of chymical oil of savin have been employ'd to wet and soften the part, and make the powder stick well: this done, dress it up, and 'twill seldom require a third application.

*A try'd medicine for an ulcer in the womb.*

468. Of true *Bitumen Judaicum*, reduced to very fine powder, let the patient take about a dram at a time, in any proper vehicle, once or twice a day.

*An astringent liquor, of great use in ulcers, and some wounds.*

469. Boil two drams of choice *Catechu*, or *Japan* earth, in a quart of spring-water; pour off the clear, and with it, by injection, or otherwise, dress the ulcers or wounds.

*For outward ulcers.*

470. Take the green bark of oak, and chop it all together, both inside and outside, into very small pieces; pour thereon good lime-water fresh made, and let it infuse, till the liquor has acquir'd a deep tincture. With this dress the ulcer once or twice a day.

*A successful water for ulcers and sores.*

471. To a quart of spring-water, add one dram of mercury sublimated, finely powder'd; and when 'tis quite dissolv'd, drop into the solution, spirit of sal-armoniac, till no more will manifestly precipitate. Then filter the mixture through cap-paper, and reserve the precipitate for other uses. The liquor that passes, keep close stop'd in a glass; and when you use it, dip linen rags therein, and apply them to the part affected twice or thrice a day.

*A speedy remedy for fits of vomiting.*

472. Take a large nutmeg, grate off one half of it, and toast the flat side of the other, till the oily part begin to ouze out; then clap it to the pit of the patient's stomach, as hot as he can well endure it, and let him keep it on whilst it continues warm; and then, if need be, put on another.

Vomiting.



## Medicinal Experiments.

### Emetic drops.

473. In compliance with some ingenious physicians, and others, who have often employ'd a medicine, that goes under the name of my emetic drops, I shall communicate the preparation of them; without pressing their use any otherwise, than by declaring, that several practitioners in physic, of differing sentiments, agree in assuring me, they have not yet found any emetic to work so effectually, nor with more ease and safety, than this liquor; which some of them prefer, by much, to other antimonial vomits; and especially to the infusion of *Crocus Metallorum*.

In preparing my vomitive liquor, I have not always employ'd the same proportion of the ingredients 'tis made of; nor did I find it necessary to be nice in this particular. But the proportion I somewhat prefer, is to take two parts of well chosen and finely powder'd antimony, and three parts of spirit of wine; which ought to be rather moderately strong, than too much rectified. These are to be distill'd together in a glass retort, fitted with a large receiver, till there come over a great part of the menstruum; which will usually, towards the close, be accompanied with red flowers, that must be separated by filtration through cap-paper; and the clear liquor put into a glass, not newly wash'd, but dry on the inside, to be kept close stopp'd from the air.

The dose is usually, to grown persons, especially at the first time, from four or five, to seven or eight drops. The vehicle may be a spoonfull or two of wine, black-cherry water, or spring-water; drinking up the liquor immediately after mixing, because there will some precipitation be made; and then taking two or three spoonfulls of the same vehicle to wash it down. It usually begins to work early, and does it without causing near so much straining as vulgar emetics, and yet makes large evacuations. Having had occasion to keep long by me some vials of these emetic drops, I observ'd, that in time, there began to subside a white powder, wherein a large part of the vomitive faculty of the medicine may be suppos'd to reside; therefore 'twill be best either to employ the liquor soon after 'tis made, or to shake the vial well, just before 'tis administr'd.

### For sharpness of urine.

Disorders  
from the urine.

474. Take of the dry matter that divides the lobes of the kernels of walnuts, beat it to powder; and of this give about half a dram at a time, in a draught of white-wine, or posset-drink made with it, or any other convenient liquor.

An



## Medicinal Experiments.

675

*An excellent emulsion in case of sharpness of urine, especially if caused by blistering plaisters.* MEDICINE.

475. Take mallows two handsfull, gum-arabic two drams, barley-water a sufficient quantity; boil all to a quart; to which add sweet almonds blanch'd one ounce, of the four greater cold seeds, of each two drams. Make an emulsion, strain, and add two ounces of syrup of marsh-mallows; and of this drink at pleasure.

*An easie diuretic.*

476. Peel off the inner skin of an egg-shell, then beat the shell to a very fine powder: give about a scruple of it at a time, in any convenient vehicle.

*A powerful medicine for the stoppage of urine.*

477. Fry chervil with a sufficient quantity of oil of walnuts, and apply a cataplasm made of it, very hot to the navel; and, if need be, to the Os pubis, or share-bone.

*For a retention of urine.*

478. Fry chervil well with fresh hogs-lard, and lay it very hot upon the patient's navel, and the adjacent parts; shifting it, if there be occasion, once or twice.

*An approved medicine to drive the stone, and cure suppression of urine proceeding from it.*

479. Take the roots of wild garlic, by some called crow-garlic, wipe them clean, stamp them well in a stone mortar, and strain out the juice; with which make a moderate draught of good white wine considerably strong, and let the patient take it once or twice a day.

*For sharpness of urine, obstruction of the menses, and their flowing too much, if the distemper be not obstinate.*

480. Give about half an ounce at a time, of the newly exprest juice of ground-ivy, in any convenient vehicle.

*An old lithotomist's medicine for suppression of urine.*

481. Give about fifty grains, or one dram, for a dose, of the Pulvis Hollandi; and if the necessity be very urgent, you may give from one dram to four scruples, or a dram and half; not neglecting in the mean while other proper remedies.

*For suppression of urine.*

482. Give about a spoonful, at a time, of bruis'd mustard-feed, in any convenient vehicle.

## Medicinal Experiments.

*A medicine almost specific for the suppression of urine.*

483. Infuse two handsfull of the flowers of French lavender, in a good heat, in a pint of brandy; and of this infusion give a small wine-glass full at a time.

*A try'd medicine for a suppression of urine, that is not very obstinate.*

484. Dissolve half an ounce of choice Castile soap, in half a pint of white-wine, or some appropriated liquor; pass the solution thro' a woollen filter, that the more unctuous parts may rest behind, and the liquor pass more clear; put to this five or six grains of saffron: divide it into two doses, whereof one is to be given a few hours after the other, if the first do not operate well.

*An experienced remedy for making bloody urine.*

485. Take the waters of the black alder, and of mallows, of each three ounces, syrup of comfrey one ounce; mix them, and let the patient take four spoonsfull four or five times a day.

*A powerful dissolving ointment for warts and tumors.*

*For warts.*

486. Take May butter, and having melted it in a moderate heat, mix with it, by little and little, as much oil of tartar per deliquium, as will give it a sensible strong tast.

*An empiric's boasted remedy for the whites.*

*The whites.*

487. Make a strong decoction of the herb ladies-mantle, and let the patient drink of it about half a pint every morning fasting; and if the case be urgent, make an injection of the same plant, boiled very tender, and let the patient make use of it from time to time.

*An excellent remedy for the whites in women.*

488. After due purging give two, three, or four grains of laudanum; and inject, four or six times a day, the following.

Take spring-water two quarts, white vitriol, and roch-alum, of each two ounces: powder, mix, and dissolve. Let the liquor settle, and use only the clear.

*A powerful medicine for the whites.*

489. Shred into a pottle of ale, two ounces of white ising-glass, and in a loosely stopp'd vessel, let the liquor simmer till about half is wasted; strain the rest, and give of it two or three ounces at a time, once or twice a day.

*For*

## Medicinal Experiments.

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MEDICINE.

Whitlows.

*For a whitlow.*

490. Beat shell-snails very well, with a convenient quantity of par-  
sley, to be applied warm to the affected part, and shifted two or three  
times a day.

*A try'd medicine for a whitlow.*

491. Beat house-snails, shells and all, in a stone-mortar, till they be  
reduced to the consistence of a cataplasm; which apply somewhat  
warm to the part affected, and keep it on for sixteen or twenty four  
hours, renewing it occasionally.

*An excellent remedy for whitlows on the fingers.*

492. Take a reddish or blackish snail, of the sort that has no  
shell, and having beaten it in a stone mortar to the consistence of a  
poultis, apply it to the part affected; renewing it once or twice, after  
it has been kept on for some hours.

*For women in labour, to bring away the child.*

493. Let the patient take about one dram of choice powder of *Womb-medi-*  
myrrh, in a draught of *Rhenish* wine or sack; or some other more *cines.*  
temperate vehicle.

*An often proved remedy to cleanse the womb of a lying-in-woman.*

494. With the juice of sheeps-forrel, and some of the strong infusion  
of the same herb, made in water, and a sufficient quantity of sugar,  
make a syrup: of which let the patient take about a spoonfull twice  
or thrice a day.

*An experienced medicine to cleanse the womb.*

495. Take a large white onion, cut it into small pieces, and boil it  
in a pint of water, or less, as if it were to be dressed for eating. And  
of this decoction give seven or eight ounces for a dose, mix'd with  
about half an ounce of fresh oil of walnuts.

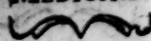
*To cleanse the womb, especially after child-bearing.*

496. Take a large white onion, about four ounces in weight, and  
boil it in about a pint of water, with any thing fit to make a very  
thin broth, till a third part, or more, of the liquor be consumed:  
of this broth, which may be made a little palatable with nutmeg, &c.  
the patient is to take six or eight ounces, twice or thrice a day.

For



## MEDICINE.



For a Prolapsus Uteri.

497. Apply to the patient's navel a pretty large cupping-glass; but let it not stay on above a quarter of an hour, for fear of injuring the part it covers.

*A good vehicle for several remedies, being of itself useful against the jaundice, and worms in children.*

Remedies for  
worms.

498. The distill'd water of the husks of walnuts, is a very good vehicle in several diseases; particularly in the jaundice: 'tis a cordial, and exceeding proper to be mixt with juleps in fevers. 'Tis, also, an excellent medicine against the worms, especially for children.

*An approved medicine against the worms in children.*

499. Infuse one dram of clean quick-silver all night, in about two ounces of the still'd water of goats-rue; afterwards strain and filter it. This quantity is to be given for one dose.

*An experienced ointment for the worms in children.*

500. Take rue, wormwood, and savin, of each a sufficient quantity; and with May butter, or fresh hogs-lard, boil the herbs softly, till you have brought the mixture to be very green. Then strain it, and put it up for use; when you employ it, first anoint with it the pit of the stomach, and part of the chest; and after a while rub it pretty well upon, and all about the navel.

*A powerful remedy for fresh wounds.*

For wounds.

501. With the juice of celandine, dress recent wounds and cuts, instead of a balsam.

*A balsam to stench the blood of fresh wounds, and to heal them speedily.*

502. Take good Venice turpentine, and in a limbec distil off a large part of it with a very moderate fire, till there remains a thick substance, of a liquid and balsamic consistence; which is the substance we seek for, and should be apply'd as a balsam.

*An excellent wound-drink.*

503. Take harts-tongue, liver-wort, wood-bugle, wood-sage, wood-betony, southernwood, wormwood, alehoof, buglofs, scabious, ribwort, white-bottles, mugwort, comfrey, mint, agrimony, strawberry and violet-leaves, cinquefoil, daisie-leaves, roots, and flowers, wild honey-suckles, wild angelica, avens, plantain, clowns, wound-wort, hawthorn-buds, oak-buds, and bramble-buds.

Gather

Gather the herbs in *May*, or as many of them as can then be had; MEDICINE, and the buds in *March*, as soon as ever they appear; measure them, and take equal quantities of them, dry them severally in the shade; and, when thoroughly dried, put them up in bags, and so keep them for use.

Then take one gallon of spring-water, one pottle of the best white-wine, and two good handfull of all the herbs, mixed well together, being dried; but if green, then one good handfull of each. Boil them in a pipkin to the consumption of half; then strain it out, put to the liquor a quart of honey, let it boil again, skim it; and when cold, put it up into bottles, stopp'd very close. Let the patient drink morning and evening about a quarter of a pint, fasting for one hour or two after. The liver-wort is best to be put in green. If you use this for any sore or ulcer in the body, lay a searcloth or plaister to it, of *Unguentum Apostolorum*, *Emplastrum de minio*, or a plaister of honey and wax.

This drink is effectual in sores, old or new, womens sore breasts, putrefied bones, causing them to scale; 'tis good for any ach in the stomach, it hath cured the king's evil, and caused bullets in the flesh to come out, tho' they had long continued there.

*An often try'd digestive, to be used instead of basilicon.*

504. Take two ounces of good *Venice* turpentine, and incorporate very well with it the yolks of two fresh eggs, and add to it a little spirit of wine occasionally; with this dress morning and evening, laying it on thicker, if the part be near some nerve, and thinner, if it be fleshy or moist.

*An excellent balsam for any green wound.*

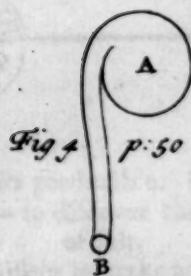
505. Take oil of *St. John's-wort*, and *Venice* turpentine, of each a like quantity; set them over the fire in a gentle heat, for half an hour, that they may incorporate.

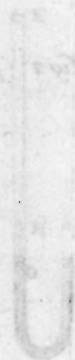
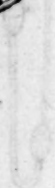
*The End of the Third Volume.*











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